Volume 34 November 15, 1959 Number 2

IOWA STATE JOURNAL OF SCIENCE

A Quarterly of Research

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PUBLISHED BY

The Iowa State University Press, *Ames*, Iowa, U.S.A.

IOWA STATE

JOURNAL OF SCIENCE

Published August, November, February, and May

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Entered as second-class matter January 16, 1935, at the post office at Ames, Iowa, under the Act of March 3, 1879.

IOWA STATE JOURNAL OF SCIENCE
Vol. 34, No. 2 November 15, 1959 pp. 127-137

AGE AND GROWTH OF CHANNEL CATFISH FROM THE DES MOINES RIVER, BOONE COUNTY, IOWA, 1955 and 1956[1]

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Abstract

Age and growth data for channel catfish, Ictalurus punctatus (Rafinesque), from the Des Moines River were determined by three independent methods. Calculated lengths at the first two annuli as determined from pectoral spine cross-sections were shorter than modes for length frequency data. Several factors were encountered in the spine technique which could cause such variations. Recorded increases in total length of some tagged channel catfish exceeded the calculated average increments. In general, the three methods substantiated each other. Less growth occurred during 1955 than 1956 probably due to decreasing summer water levels in 1955. Weight increases more rapidly than the cube of the total length. The number of eggs per mature female ranged from 2,682-9,731 and increased with age, length, and weight of the fish.

Introduction

Age and growth data were collected on channel catfish taken from the Des Moines River, Boone County, Iowa in the vicinity of the Y.M.C.A. Camp (R.27W, T.85N, Sec.35 and 36; R.27W, T.84N, Sec.1 and 12) during 1955 and 1956. Stream bottom is chiefly sand-gravel, with some rubble and boulders and with sand-silt in pools. During low-water stages in late summer and fall as much as one-half of the river bed may be exposed. The only water exceeding six feet in depth at these times is in a few scattered holes.

Ages of the catfish were determined by counting the rings on cross-sections from pectoral spines. The use of spine cross-sections for the determination of age and calculated growth of channel catfish was first described by Sneed (1951).

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[1]Journal Paper No.J-3688 of the Iowa Agricultural and Home Economics Experiment Station, Ames, Iowa. Project No.1373. Iowa Cooperative Fisheries Research Unit sponsored by the Iowa State Conservation Commission and Iowa State University of Science and Technology, with the cooperation of the Fish and Wildlife Service, United States Department of Interior.

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Determination of Growth from the Spines

Pectoral spines were removed from the channel catfish in the manner described by Sneed (1951) and stored in coin envelopes. Thin cross-sections of 0.5 millimeters or less were cut from the dried spines with dental separating saw blades. Sections were obtained just above the visible terminal portion of the basal groove on the pectoral spine. Projections of the sections were enlarged for viewing by means of a "Bioscope." Transparency was increased by soaking the smaller sections in water and the larger sections in alcohol. Alcohol increased the differentiation of translucent and opaque zones (Probst and Cooper, 1955).

Sneed (1951) stated that more accurate measurements of the annuli could be determined if measurements were made along the expanded edge of the spine cross-sections. Marzolf (1955) made comparisons of age and growth measurements using pectoral spines and vertebrae. (Appelget and Smith, 1951, used rings on the vertebrae for aging catfish.) After using the expanded posterior portion of spine cross-section , Marzolf suggested that measurements along the anterior radius of the spine would give better results. The annuli on the anterior radius are often so crowded as to be difficult to distinguish, however. In the present study, relative positions of annuli with respect to center of the lumen and the maximum posterior edges were marked where the outer edge of the light zone (transmitted light) intercepted a tab board strip placed over the projected image. In some instances, the first annulus intercept could not be detected on the expanded posterior portion of the spine cross-sections of older fish. The erosion and loss of the first annulus in spines from older fish has been discussed by Marzolf (1955).

Several variables were noted in the technique of preparing and viewing the spine cross-sections which would affect the calculation of a body-spine relationship.

1. Difficulties arise in trying to obtain the section from the same location in all spines. Since the spine tapers and becomes rounded rapidly, adjacent sections decrease in size. Marzolf (1955) illustrated the continuous outward change in the basal groove with growth. Thus, spine sections cut in relation to the end of the basal groove would be located farther toward the tip with increased age.

2. The curved shape of the spine causes difficulty in obtaining perpendicular sections. Harrison (1955) discussed the problem of cutting the spine sections in the same plane and position.

3. The center of the larger lumen in the spine of older fish was more difficult to determine. As previously mentioned, the first annulus did not extend around the lumen of cross-sections from older fish. In these instances, the questions arose as to whether the center of lumen or an estimate of the center of the annulus should have been used as the base of spine-radius measurements.

4. The maximum expanded portion of all annuli did not always lie in a straight line along the maximum radius of spine.

5. The first annulus was approximately circular around the lumen; whereas the other annuli extended more into the expanded posterior portion of the spine. In age group II fish, the first annulus width would not be out of proportion as much as when compared to other annuli of older fish.

6. The projection instrument, a "Bioscope," introduced an error into the reading of annuli marks and spine radii. Magnification by the projector varied in the image field. Using medium power lens (10x) at the same focus, magnifications of 70 times were obtained in the center but magnifications ranged up to 90 times at the edge or 28 per cent more than in the center of the image field. This distortion increased progressively from the center to the edge of the field. Examination of the image field of other projection equipment has revealed that this distortion was not confined to the equipment used in this study.

All of the above variables caused greater errors in measuring the radii and annuli of larger cross-sections of older catfish. It was considered unwise to compute the body-spine relationship and make a mathematical correction since these errors are not constant for fish of all size ranges. An approximate growth rate was computed for each fish on the assumption that the growth in cross-section of the spine was directly proportional to growth in length of the fish.

Growth Rates of Channel Catfish

Calculated growth was determined from pectoral spines of 504 channel catfish collected with nets and electric shocker during 1955 and 1956 (Table 1). Three additional pectoral spine cross-sections were discarded as atypical. Two sections had regenerative growth while the third section had an excessive calculated length (19.8 to 25.1 inches) between annulus eight and nine. Because the body-spine relationship was subject to many variables, the calculated lengths in Table 1 should only be considered approximations. Probably fewer errors are present if comparisons are made of the last two or three seasons of growth (Table 2). These data indicate that growth was greater in 1954 than in 1953 and 1955.

Additional data on the growth rates in 1955 and 1956 were obtained from length-frequency data of hoopnet and wire trap catches (Figs. 1, 2). The age classes through II are fairly evident from the size distributions. The lengths of the age group I fish in the fall are somewhat greater than the computed lengths at the second annulus (Table 1), and the same is true for the age group II fish with respect to the third annulus, but the differences are not great and may easily be caused by the factors considered in the previous section. Comparisons of peaks at the same time of year in 1955 and 1956 indicate that growth (total length) was greater in 1956. Increase in total length was much slower after July in 1955, whereas growth occurred over a longer period in 1956.

Table 1. Average calculated total length (inches) at each annulus from pectoral spine cross-sections of channel catfish taken in 1955 and 1956 from Des Moines River, Iowa.

Year class	Age group	Number of fish	1	2	3	4	5	6	7	8	9	10	11	12	13
1955	I	27	2.1												
1954	II	191	1.7	5.0											
1953	II	1	2.4	5.6											
	III	79	1.9	5.4	8.0										
1952	III	25	1.9	5.3	8.9										
	IV	40	2.1	4.8	8.6	10.9									
1951	IV	17	1.9	4.5	7.3	10.6									
	V	14	1.9	4.3	7.1	10.6	12.7								
1950	V	6	2.0	4.3	7.0	9.2	12.0								
	VI	15	-	4.3	7.3	9.6	12.5	14.5							
1949	VI	12	-	4.7	7.3	10.1	12.7	15.9							
	VII	23	-	4.5	7.3	9.9	12.4	15.5	17.6						
1948	VII	12	-	4.4	7.2	10.0	12.3	14.6	16.9						
	VIII	19	-	4.1	6.6	9.1	11.8	14.5	17.4	19.2					
1947	VIII	12	-	5.0	7.2	9.8	12.4	14.9	17.2	19.1					
	IX	4	-	4.7	6.9	9.4	11.8	14.7	17.3	19.2	20.8				
1946	IX	4	-	4.6	6.3	8.5	10.9	13.6	16.3	18.9	20.9				
	X	1	-	4.6	6.0	9.3	12.4	16.3	19.4	21.4	23.8	25.2			
1945	XI	1	-	5.3	7.8	12.5	16.6	19.2	21.6	23.2	24.8	25.6	26.9		
1943	XIII	1	-	4.9	7.8	13.0	15.4	16.6	19.0	20.6	21.6	22.2	23.8	25.2	26.6
Av. calculated length			1.8	4.9	7.7	10.1	12.3	15.0	17.4	19.3	21.5	24.3	25.4	25.2	26.6
Av. annual increment			1.8	3.2	2.9	2.7	2.6	2.7	2.4	1.9	1.8	0.9	1.4	1.4	1.4
Calculated weights (lbs.)[1]			0.002	0.03	0.13	0.31	0.57	1.07	1.70	2.35	3.30	4.85	5.57	5.43	6.44
Weight increments			0.002	0.03	0.10	0.19	0.30	0.50	0.63	0.65	0.79	0.54	0.91	0.89	1.01

[1] Log Weight = -1.6561 + 3.1334 Log total length.

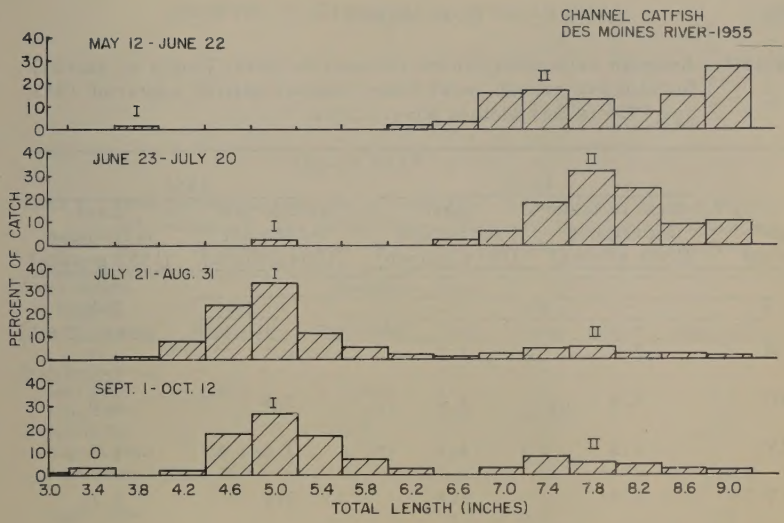

Figure 1. Length frequencies of channel catfish in hoop net and wire tra. catches for 1955, Des Moines River, Iowa.

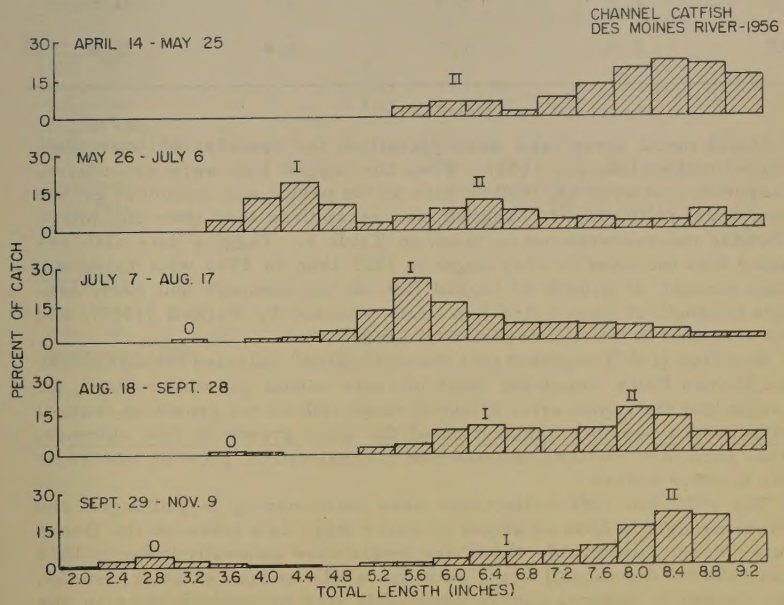

Figure 2. Length frequencies of channel catfish in hoop net and wire trap catches for 1956, Des Moines River, Iowa.

Table 2. Average calculated growth increments (total length in inches) for last two growth years from channel catfish captured 1955 and 1956 in Des Moines River, Iowa.

	Year caught			
	1955		1956	
Age group	Next to last increment (1955 growth)	Last increment (1954 growth)	Next to last increment (1954 growth)	Last increment (1955 growth)
I	-	-	-	2.1
II	2.4	3.2	1.7	3.3
III	3.4	3.6	3.5	2.6
IV	2.8	3.3	3.8	2.3
V	2.2	2.8	3.5	2.1
VI	2.6	3.2	2.9	2.0
VII	2.3	2.3	3.1	2.1
VIII	2.3	1.9	2.9	1.8

Monel metal strap tags were placed on the opercles of over 3000 channel catfish (Muncy, 1958). When the tagged fish were recaptured, measured, and weighed, further data on the period and amount of growth were secured (Table 3). Tagged fish recaptured less than one month following release were not included in Table 3. Tagging data also revealed less increase in total length in 1955 than in 1956 with relatively small amount of growth of tagged fish in late summer and early fall. Loss in length of tagged fish has been reported by Purkett (1957), and was observed in 9 cases reported in Table 3.

Harrison (1957) reported that channel catfish collected throughout the Des Moines River completed most of their annual growth by July. He thought that the suppressive effect of rough fish on the growth of channel catfish was a possible explanation of the slow growth in late summer. Other published studies indicated that channel catfish grow in late summer in other waters.

The 1955 and 1956 collections were made during a prolonged and severe drought in Iowa as shown by water stage data taken at the Boone Water Works Dam (Table 4). Water levels were generally lower in 1956 than 1955 but did not fall to the extreme levels in late summer months. The growth of channel catfish apparently was maintained later in the summer in 1956 and 1955, perhaps as a result of fairly stable water levels. Water levels in the study area are a primary factor in changing the habitat and indirectly the competition.

Table 3. Mean increase in total length in inches of channel catfish between tagging and recaptures, Des Moines River (Numbers in parentheses indicate number of recaptured fish. All others represent single recaptures.)

Total length at tagging	Recapture dates					
	1955	1956				
Date of tagging	Sept.-Oct.	April-May	June	July	August	Sept.-Nov.
7-10 inches						
May 1955	0.7	2.9(2)	-	-	-	3.9
June 1955	-	0.6(4)	1.2	3.5(2)	-	2.4
July 1955	0.4	0.3	-	-	-	-0.1
August 1955	-0.1(2)	0.2(7)	1.3	1.4	-	-
September 1955	0.1	0.	0.8	-	-	2.4(2)
April 1956			-	1.3	-	2.8
May 1956				1.4(2)	1.8(3)	3.3
June 1956				-	0.7(3)	1.7(4)
July 1956						0.5(8)
August 1956						0.2
10-15 inches						
May 1955	-	3.8	-	-	-	-
June 1955	-	1.1(3)	-	-	-	-
July 1955	-	0.9(2)	0.4(2)	-	-	-
August 1955	-	-	-	-	-	-
September 1955	-	0.1(2)	-	-	-	-
May 1956				0.9(3)	-	2.3(3)
June 1956				0.1(2)	0.3(2)	1.0(3)
July 1956						0.3(5)
15-20 inches						
May 1955	-	-	1.0	-	-	-
June 1955	-	-	0.1	-	-	-
July 1955	-0.3	-0.9	0.0	-	-	-
September 1955		-0.3	-	-	-	-
May 1956			-	-0.3	-	-
June 1956			0.4	-	0.2	0.3

Table 4. Comparison of Des Moines River 1955-56 average monthly water level stages with 15-year average (1933-47 inclusive)

Year	Water gauge reading in feet				
	May	June	July	August	September
15 year average	2.1	2.8	1.4	1.1	1.2
1955	1.1	1.0	0.85	0.25	0.20
1956	0.46	0.42	0.40	0.40	0.27

Length-Weight Relationship

Ponderal indexes (C) of all channel catfish for which lengths and weights were available were computed as follows:

$$C = \frac{W \times 10^5}{L^3}$$

where W = weight in pounds
and L = total length inches.

Average C values increased with the length of the fish, at least after 13 inches total length (Table 5). Comparison of ponderal indexes for fish collected in different months failed to indicate consistent seasonal trends. Tagged fish appeared to have about the same ponderal indexes at recapture as untagged fish of the same lengths.

The mathematical relationship between total length and weight can be described by the formula:

$$\text{Log } W = -1.6561 + 3.1334 \text{ Log } L.$$

For ease in computing the constants in this formula, five channel catfish were chosen at random from each half inch size group containing more than five individuals and all specimens were used in the other half inch size groups. The regression line was then fitted to the logarithms of length and weight of 180 fish. The regression coefficient (3.1334) was found to be significantly greater than 3.0 at the 0.01 level of probability ($t = 4.85$ with 178 degrees of freedom) and therefore it may be said that the weight increases more rapidly than the cube of the total length. The correlation coefficient (r) was 0.993.

Conversion factors for various length measurements of the channel catfish were determined from 421 fish arranged by half-inch size groups, ranging from 3 to 23 inches total length. Since there was no tendency for the ratios of standard to total lengths or fork to total lengths to be correlated with the length of the fish, the average ratios give the best conversion factors:

Table 5. Average weights, calculated weights, and average ponderal indexes for channel catfish, Des Moines River, Boone County, 1955-56.

Average total length (inches)	Number of specimens	Ponderal index		Weight in pounds	
		Mean	Range	Mean	Calculated[1]
3.6	4	29	20-36	.015	.012
4.3	5	29	23-35	.024	.021
5.4	15	32	24-38	.050	.044
6.6	23	30	25-38	.090	.082
7.5	37	30	14-36	.130	.122
8.5	139	29	24-45	.173	.180
9.4	92	28	18-38	.231	.247
10.4	57	29	20-38	.325	.339
11.4	36	29	20-47	.425	.452
12.5	20	27	15-35	.521	.604
13.4	30	29	16.45	.697	.751
14.4	13	32	25-39	.948	.941
15.4	9	31	26-37	1.148	1.161
16.6	13	32	27-42	1.418	1.469
17.5	8	32	18-37	1.664	1.733
18.3	18	35	24-47	2.115	1.994
19.4	8	36	30-40	2.600	2.394
20.4	12	37	32-43	3.172	2.801
21.4	7	32	27-41	3.301	3.255
22.4	4	37	34-39	4.22	3.760
23.4	4	38	34-41	4.86	4.31
24.3	1	35	-	5.06	4.35
25.1	1	45	-	7.06	5.37
26.4	2	47	47-48	8.78	6.18
Total	558	29.7	14-48	-	

[1] Log W = 1.6561 + 3.1334 Log L

Fork length = 0.876 total lengths
Standard length = 0.734 total lengths

Fecundity

The numbers of eggs in the ovaries from 12 mature female catfish increased with the age, length, and weight of the fish (Table 6). The mathematical expression of the regression of number of eggs (Y) on total length of the fish in inches (X) is:

$$Y = -5202 + 718.4X$$

with a correlation coefficient (r) of 0.897.

The regression of number of eggs on weight of the fish in grams (W) is:

$$Y = 2.597 + 5.256W$$

with a correlation coefficient of 0.855.

Approximately 15 per cent of the total weight of mature females was eggs.

Table 6. Egg counts of channel catfish collected in the Des Moines River, Boone County, June 5 to July 16, 1956.

Age group	No.	Standard length (inches)	Total length (inches)	Weight (grams)	Weight of eggs (grams)	Number of eggs
V	2	9.0-9.2	11.8-12.3	237-258	38-45	2682-4036
VI	3	9.2-10.0	12.1-16.7	270-794	41-164	2729-7233
VII	4	11.8-13.8	15.1-18.2	482-1077	91-147	5973-7547
VIII	2	14.2-16.5	17.9-20.2	737-1389	118-235	6884-9721
IX	1	13.7	17.5	879	155	8299

Acknowledgments

Appreciation is expressed to Dr. Kenneth D. Carlander for his guidance during the research and for his assistance in the preparation of this manuscript. Thanks are also due Marvin M. Buchholz, Andreas A. Paloumpis, and Kent I. Schach for their assistance in collection of field data. Use of the facilities of the Des Moines Y.M.C.A. Camp as field headquarters was greatly appreciated. The author's wife, Betty, assisted in collection and preparation of the data.

Literature Cited

Appelget, J. and L.L. Smith, Jr. 1951. The determination of age and rate of growth from vertebrae of the channel catfish, Ictalurus lacustris punctatus. Trans. Am. Fish. Soc. 80:119-139.

Harrison, H.M. 1955. Further studies on the catfish in the Humboldt area of the Des Moines River. Iowa Conserv. Comm. Biol. Rept. 6(4):24-32. (mimeo.)

_____. 1957. Growth of the channel catfish, Ictalurus punctatus (Rafinesque), in some Iowa waters. Proc. Iowa Acad. Sci. 64:657-666.

Marzolf, R.C. 1955. Use of pectoral spines and vertebrae for determining age and rate of growth of the channel catfish. Jour. Wildl. Mgt. 19:243-249.

Muncy, R. Jess. 1958. Movements of channel catfish in Des Moines River, Boone County, Iowa. Iowa State Coll. Jour. Sci. 32(4):563-571.

Probst, R.T. and E.L. Cooper. 1955. Age, growth and production of the lake sturgeon (Ascipenser fulvescens) in the Lake Winnebago region, Wisconsin. Trans. Am. Fish. Soc. 84:207-227.

Purkett, C.A., Jr. 1957. A study of the tagged fish present in a fishery census station. In "Symposium on Evaluation of Fish Populations in Warm-water Streams," pages 12-13. Iowa Coop. Fish. Res. Unit, Iowa State College, Ames, Iowa. (mimeo.)

Sneed, K.E. 1951. A method for calculating the growth of channel catfish Ictalurus lacustris punctatus. Trans. Am. Fish. Soc. 80:174-183.

IOWA STATE JOURNAL OF SCIENCE
Vol. 34, No. 2 November 15, 1959 pp. 139-146

A QUANTITATIVE DETERIORATION RATING SCALE FOR SHELLED CORN[1]

R.W. Lichtwardt[2] and G.L. Barron[3]

One problem in attempting to devise a quantitative evaluation of the degree of deterioration in a sample of corn lies in defining the entity which one wishes to measure. Probably no definition of deterioration of grain would find universal acceptance, for it would depend in part upon the intended use of the grain and upon establishment of certain basic standards of quality with which degrees of spoilage could be compared. Perhaps a definition of deterioration, as applied to harvested field corn which is not to be planted, might be stated as any unfavorable changes in the grain which decrease the quantity or quality of its food value or palatability, or which lessen its suitability for storage or processing.

The grading standards adopted by the grain trade are of little value to the investigator studying spoilage in grain, for the grading system depends only in part upon actual deterioration (in fact, only a few symptoms of spoilage are considered), and may lean heavily upon practical considerations. For instance, the presence of stones or cinders in a sample of otherwise good corn reduces the grain to sample grade; this foreign material may be very important in marketing, but is of little consequence to the condition of the grain *per se*. There is also an element of artificiality in the present standards, as exemplified in cases which have come to our attention in which stored grain, which had developed outward signs of molding (indicating probable intense internal mold activity), had been considerably upgraded, such as from No. 3 to No. 1 yellow corn, subsequent to routine transfer from one bin to another. In such cases the general appearance of the grain may have been improved due to drying and cleaning of the kernels and loss of odor and foreign material, but the possible irreversible chemical and physical damage to the kernels by the molds was not considered.

Microorganisms are known causal agents of deterioration in grain, and it is probable that in the vast majority of cases, under normal storage practices, fungi are the primary instigators of spoilage, or at least play an important secondary role in the process. Fungi probably also are directly or indirectly responsible for most of the chemical changes

[1] The work presented in this paper was supported by the Agricultural Marketing Service, USDA, under Contract No. 12-25-010-191.

Journal Paper No. J-3620 of the Iowa Agricultural and Home Economics Experiment Station, Ames, Iowa. Project No. 1300.

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The authors express their appreciation to Dr. J. C. Gilman for his counsel during the progress of these investigations, and they thank Dr. L. H. Tiffany for her assistance with the manuscript.

which have been used as indices of deterioration in stored grain, such as increases in fat acidity and reducing sugars or decreases in nonreducing sugars.

In the course of our studies of deterioration of shelled corn we have found it desirable to be able to assign a value to a sample of grain which indicates the extent of undesirable change or deterioration which the grain has undergone. The total presence of fungi in the kernels has not always been a satisfactory measure of deterioration, because all species or genera of molds do not seem to affect the quality of corn in an equal manner. Diplodia and Fusarium, for instance, may be present in a large percentage of kernels in a bin of grain which by all other criteria is in excellent condition. These fungi are capable of invading the kernels prior to harvest and may remain viable in dried grain for years after it is stored without any apparent damage to the grain. On the other hand, an equal percentage of kernel infection by certain species of Aspergillus and Penicillium is a rather good sign that the corn has undergone unfavorable storage conditions, and consequently some deterioration, either in the crib or in the bin, for the species in question normally do not invade kernels in the field to any great extent.

One criterion which we feel can help to determine grain quality is the amount of infection by two genera of fungi, which infection we designate as the Aspergillus-Penicillium value, or simply the A-P value. The A-P value consists of the summation of the percentages of kernels infected internally by each species of Aspergillus and Penicillium in the sample. Since individual kernels may be infected by more than one species, the summation of the percentages of infection may exceed 100. Approximately the same relative values can be obtained by using only species of fungi belonging to the Aspergillus glaucus group and the Penicillium cyclopium - P. viridicatum series, but in some instances, especially in more advanced cases of deterioration, other species of Aspergillus and Penicillium may be significant. Using all species of the two genera has a practical advantage in that a distinction need not be made between species, and the genera themselves are easily distinguished from other fungi associated with corn.

Fungi alone are not necessarily an indication of the extent to which a batch of grain has deteriorated, even when the kinds of fungi as well as their frequencies are considered. There are some instances in which the grain obviously has suffered from deterioration processes, as measured by other standards, and yet the kernels contain relatively few fungi; some of the ways in which this can happen are suggested later. In such cases, the germination percentage of the grain usually is low, and germination probably is the most direct means of measuring these unfavorable changes in the grain.

Fig. 1 is a chart which plots the percentage germination of a sample of grain against the A-P value found in the sample. The vertical and horizontal divisions of the chart were selected after consideration of all the data which we had from over six hundred samples collected in Iowa over a period of two years. These samples represented all degrees of deterioration of corn stored in all commonly-used types of bins located in scattered areas throughout the state with differing climatic and other storage conditions.

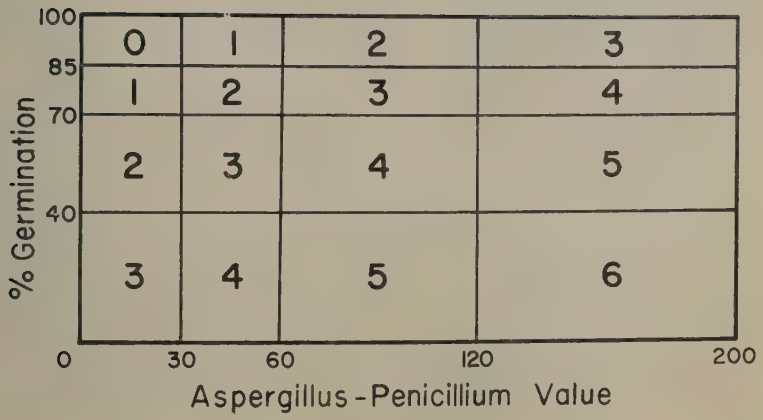

Fig. 1. Deterioration chart for shelled corn, based on percentage germination and A-P value (see text). The deterioration ratings range from 0 (excellent condition) to 6 (extremely deteriorated).

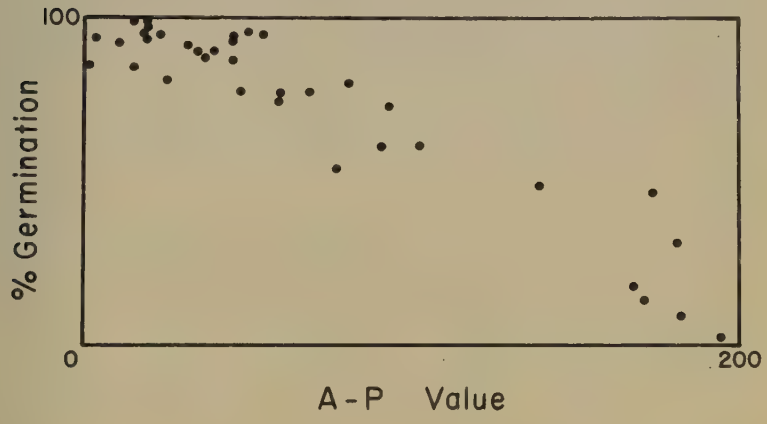

Fig. 2. Deterioration pattern of shelled corn from some farm bins (undisturbed grain) located in central Iowa.

The numbers in each box designate the deterioration rating of the samples which fall within them. The ratings range from 0 (excellent condition) to 6 (extreme deterioration). Each number might be described as follows:

0 = excellent
1 = good
2 = fair
3 = slightly deteriorated
4 = moderately deteriorated
5 = deteriorated
6 = extremely deteriorated

Fig. 2 shows a deterioration pattern of shelled corn based on averages of all samples collected over a period of two years from eighteen bins located in central Iowa (Story County). Averages of the upper 1 foot of grain and grain from a level of 4-5 feet below the surface are shown separately for each bin. It can be seen that these averages are rather well-correlated, considering the many other factors that might influence either of the two variables used.

The original reason for devising this deterioration rating scale was for use with grain from bins of undisturbed corn, that is, corn which is not regularly stirred or otherwise excessively handled during the storage period. We found, however, that the ratings proved satisfactory when we plotted the results we had obtained from shelled corn stored in Commodity Credit Corporation binsites, where the upper grain layers normally are stirred at regular intervals and where more consideration is given to insect control. But there was a tendency in some cases for the germination of the samples to be low. At the same time there was no corresponding large A-P value as might ordinarily be expected. Instances of this sort are illustrated in Fig. 3.

Fig. 3 represents averages of data from thirteen bins located in CCC binsites in central Iowa (Story County). The averages for each bin are shown separately for the upper 1 foot of grain and grain from the 4-5 foot level. The years of harvest were from 1952 to 1955, and collections were made within a two year period. The surface grain in some of the bins had shown evidence of considerable molding and had been stirred as often as seven times during one month in order to break up the surface crust and reduce moisture.

The phenomenon of low germinability in grain, and which has at the same time a relatively low A-P value, might be explained in many ways, any of which could account for the deviations in Fig. 3 and similar cases:

1. Certain types of insecticides when applied to corn in bins may kill the kernels, especially if the grain is not particularly dry. In addition, it is possible that fungi in the kernels might also be killed by strong concentrations of insecticides.

2. Overheating of the grain during artificial drying, or otherwise improperly drying the grain, may reduce the grain's germinability.

3. Insect activity at moistures too low to permit much mold growth may damage or destroy the kernel embryos.

4. Prolonged drying and heating of surface grain by radiated heat under the roof of the bin could conceivably reduce germinability, and might also kill some of the fungi within the grain, especially if the mycelium has not sporulated.

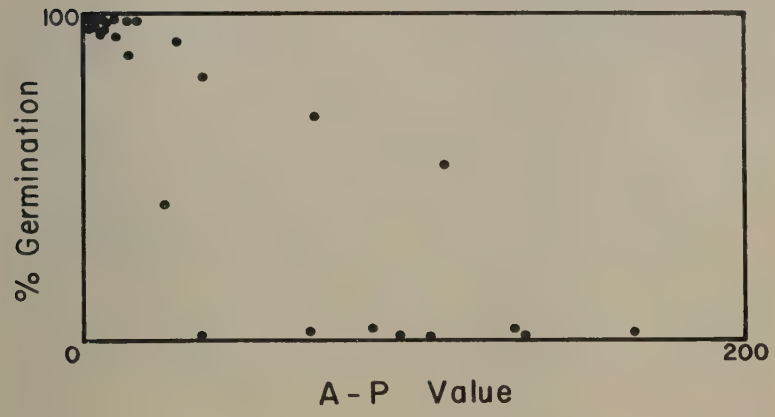

Fig. 3. Deterioration pattern of shelled corn from some CCC bins (stirred grain) located in central Iowa.

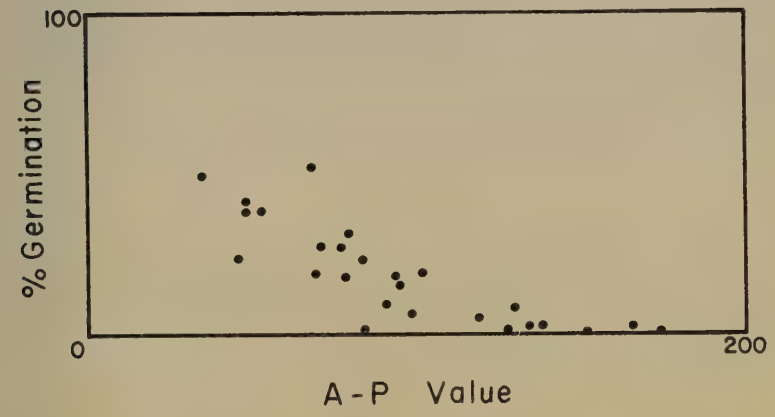

Fig. 4. Deterioration pattern of 1952 shelled corn from some CCC bins (stirred grain) from locations scattered throughout Iowa.

5. The presence of Aspergillus restrictus in kernels, one of the A. glaucus group, often is not detected by our usual methods, because of its very slow growth from inside the grain when identification is made in moist chambers or on nutrient medium. In some samples we do find high counts of this species when the surface-sterilized grain is ground and plated by a technique which we use for quantitative internal mold counts.

6. The presence of certain yeast and bacterial infections within corn may not be easily detected because of their limited growth on the outside of the kernels when the grain is placed in moist chambers or on nutrient medium. Also, these organisms have been observed to inhibit the growth of certain fungi, such as those belonging to the Aspergillus glaucus group; if this is not taken into account it results in a lower A-P value. Candida in particular, a filamentous, non-ascospore-forming yeast, may invade grain which has not dried down sufficiently or rapidly enough, or which has become rewetted during storage, and its visual detection in some situations may require considerable care. However, its presence in significant amounts usually can be detected by a sour or yeasty odor which it imparts to grain kept under moist conditions. Perhaps the presence of Candida is one of the most important factors in cases of very low germination accompanied by relatively low detectable infection by aspergilli and penicillia. A practical method of compensating for the presence of Candida would be to throw the deterioration rating into the next higher category if the grain possesses a sour or yeasty odor.

Figs. 4, 5, and 6 represent three harvest years of corn, 1952, 1953, and 1954, respectively. These three graphs contain data from a total of 540 samples of shelled corn collected during the summer of 1956 from locations scattered throughout Iowa. Each point on the graphs represents the average of the samples from one of thirteen sections of Iowa, and averages for the upper 1 foot of grain and grain from the 4-5 foot level are shown separately.[1] In these graphs we again see, as in Fig. 3, a tendency for rather low germinability accompanied by relatively low A-P values, which contrasts with the pattern for undisturbed grain (Fig. 2).

SUMMARY

A rating scale is proposed for experimental use for expressing quantitatively the degree of deterioration in samples of shelled corn, based on the germinability of the kernels and the amount of infection by species of Aspergillus and Penicillium.

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[1] The degrees of deterioration shown in these three graphs and in the other figures in this paper are not intended to represent average deterioration patterns in the respective types of storages or harvest years. The samples were originally chosen with other objectives in mind, and some were biased with respect to the amount of deterioration present.

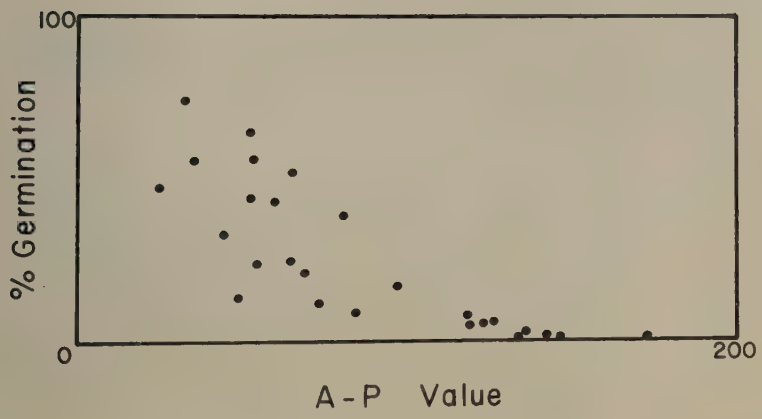

Fig. 5. Deterioration pattern of 1953 shelled corn from some CCC bins (stirred grain) from locations scattered throughout Iowa.

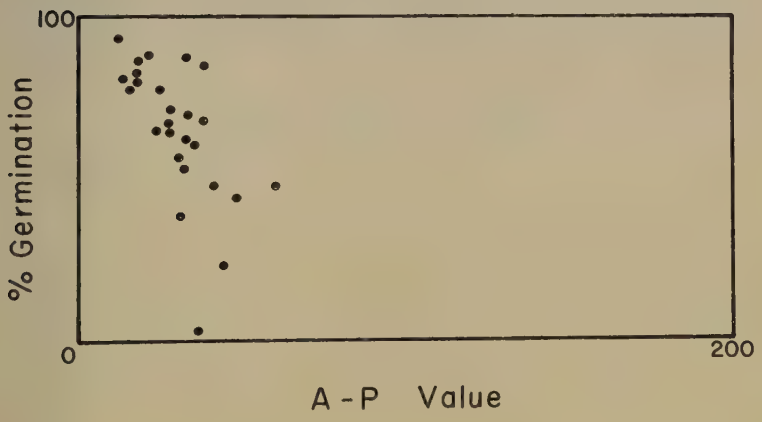

Fig. 6. Deterioration pattern of 1954 shelled corn from some CCC bins (stirred grain) from locations scattered throughout Iowa.

REFERENCE

Lichtwardt, R.W., G.L Barron, and L.H. Tiffany. 1958. Mold flora associated with shelled corn in Iowa. Iowa State College Jour. Sci. 33:1-11.

IOWA STATE JOURNAL OF SCIENCE
Vol. 34, No. 2 November 15, 1959 pp. 147-155

QUANTITATIVE ESTIMATIONS OF THE FUNGI ASSOCIATED WITH DETERIORATION OF STORED CORN IN IOWA[1]

G.L. Barron[2] and R.W. Lichtwardt[3]

Quantitative estimations of the molds in cereal grains have been made by several workers but particularly by Christensen and his associates at the University of Minnesota. Christensen (2) developed his technique as a method for counting molds in samples of flour. Briefly, the method consisted of weighing out two grams of flour and suspending this in a known volume of 0.5% saline solution; a dilution series was made from this primary suspension and one millilitre aliquots were pipetted into petri plates, a malt-salt agar added, and the mixture swirled to give an even distribution of the suspension. The results were expressed as molds per original gram of flour (m.p.g.). This method was extended by Christensen and Gordon (4) to estimate the mold flora of stored corn and wheat. In these studies the assays were made by first grinding the cereal to a powder in a Wiley type mill. The mill was cleaned between lots and the first portion ground was discarded to prevent any serious contamination. In later work Bottomley et al. (1) using essentially the same technique substituted 0.3% agar for the saline solution as the suspension medium. Quantitative estimations were carried out by Tuite and Christensen (7) on the mold flora of barley but in these studies 2 grams barley were comminuted in a Waring blendor in 500 ml of sterile 0.2% agar to give the primary suspension.

In all the above experiments the grain was not surface sterilized prior to grinding and the estimations therefore include fungus material both in and on the grain.

MATERIALS AND METHODS

Experiments were carried out repeating the techniques of earlier workers using a Wiley type mill and the method outlined by Bottomley et al. The mill was cleaned thoroughly between samples and swabbed down with 70% alcohol. The sieve was similarly treated and sterilized by flaming lightly. One experiment showed that a sterile sample, following

[1] The work presented in this paper was supported by the Agricultural Marketing Service, USDA, under Contract No. 12-25-101-191.

Journal Paper No. J-3690 of the Iowa Agricultural and Home Economics Experiment Station, Ames, Iowa. Project No. 1300.

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The authors express their sincere appreciation to Dr. L. H. Tiffany and Dr. J. C. Gilman for their generous assistance throughout these investigations.

a highly contaminated sample, picked up over 1000 molds per gram from the mill; moreover, as corn could not be surface sterilized conveniently before grinding this method was discontinued.

Preliminary experiments using surface sterilized corn and a Waring blendor showed that this machine could not satisfactorily break down the corn, especially the pericarp and horny endosperm which introduced difficulties in pipetting and dilution work.

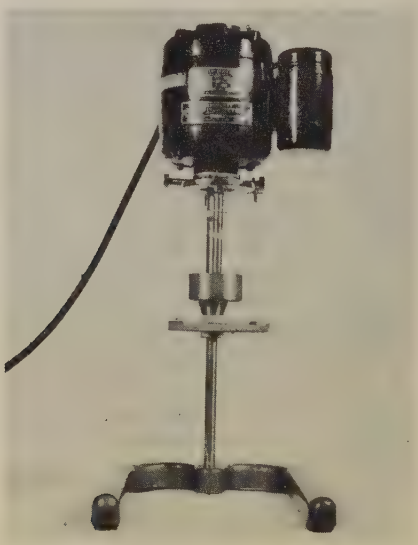

Fig. 1. The Sargent centrifugal wet mill No. 2 used for grinding corn samples.

A method was developed using a Sargent centrifugal wet mill No. 2 (Fig. 1) for grinding corn samples. A number of experiments were carried out varying the weight of corn, volume of liquid, and time of grinding. The best results were obtained when 25 gms of corn were ground in 250 ml of 0.2% sterile agar for 35 minutes. From this primary suspension a dilution series was made by pipetting 5 ml aliquots into 45 ml of sterile 0.2% agar in 4 oz medicine bottles and repeating to give a 1/10, 1/100, 1/1000, etc. series. From three selected dilutions, 1 ml aliquots were pipetted in triplicate into petri plates. Malt-salt agar (2% malt extract, 6% salt) was poured into the plates and the mixture swirled to give an even suspension. Plates were incubated three days at room temperature prior to counting and reinspected at intervals to confirm species identifications or observe the appearance of any slow-growing fungi.

The corn was surface sterilized before grinding by immersing for 30 seconds in 70% alcohol followed by two minutes in 1/1000 mercuric chloride and was finally rinsed in sterile distilled water. To prevent external contamination while grinding, a hood was designed and fitted over the grinding parts of the mill. Control samples remained sterile after grinding for one hour and plating out 5 ml replicates of the primary suspension, indicating that the technique gave satisfactory sterile grinding. For most samples external contaminations are not important since, being at a relatively low concentration, they are readily diluted out; however, in comparatively undeteriorated samples they become increasingly important.

After the ground sample is removed, the mill is spun in clean water to remove debris, swabbed down with 70% alcohol, spun for two minutes in 1/1000 mercuric chloride and rinsed in 70% alcohol. The method using the Sargent centrifugal wet mill as outlined above offers two primary advantages over previously used methods: (1) it permits wet surface sterilization of the corn immediately prior to grinding and (2) the mill can be effectively and quickly sterilized between samples.

Samples processed in these studies were collected from Commodity Credit Corporation binsites through the agency of the county A.S.C. offices. Each county agent selected three bins of CCC corn representing one bin each of currently molding 1952 and 1953 corn and one bin of high grade 1954 corn. From each bin, samples were taken representing the upper six inches or top layers of corn and mailed in airtight containers to our laboratory. In all, 256 samples from 95 Iowa counties were collected and processed in the summer of 1956.

RESULTS

The average suitability of corn for storage varies considerably from one year to the next. Thus one year's harvest may show considerably less deterioration than another during the same or even a longer period of storage. Such variations are difficult to express even on a relative basis due to the difficulties in obtaining quantitative data on the molds involved in these different years.

Differences in suitability for storage of 1952 and 1953 harvests are indicated (Table 1) by the greater frequency of the molds significant in deterioration as dominants or co-dominants in the latter years. These differences are much more marked when they are expressed as total mold counts per gram as in Table 2. In every case, with the exception of Aspergillus repens and to some extent A. chevalieri var. intermedius, the counts are much greater from 1953 harvests than from 1952 despite the fact that the latter corn had been stored one year longer. It will be remembered that both these lots of corn were purposely selected as representing moldy corn, and on this basis observed deterioration differences between the two years would tend to be minimized. Thus on an over-all basis, in comparisons between samples collected as being of the same deterioration group, the 1953 corn yielded 4 to 5 times the number of mold counts per gram obtained from the 1952 samples. If counts of Fusarium moniliforme are omitted from totals (on the basis

Table 1. Number of recordings of the principal fungi associated with the deterioration of 256 top samples of stored corn from three harvest years.

Fungus	1952	1953	1954	Number of recordings
*Aspergillus ruber	38	37	12	87
Penicillium spp.	20	27	7	54
Penicillium cyclopium	18	20	15	53
*Aspergillus restrictus	23	25	0	48
Fusarium moniliforme	1	5	30	36
*Aspergillus amstelodami	11	23	5	39
*Aspergillus chevalieri	7	15	6	28
*Aspergillus chevalieri var. intermedius	8	11	6	25
Candida sp.	9	14	2	25
*Aspergillus umbrosus	6	16	0	22
Aspergillus candidus	7	9	5	21
*Aspergillus repens	8	7	3	18
Aspergillus flavus	9	2	2	13
Penicillium viridicatum	4	6	0	10
Aspergillus versicolor	2	5	1	8
Mucor sp.	0	0	6	6
Absidia repens	2	0	2	4
Aspergillus niger	0	1	0	1

* Aspergillus glaucus group.

that this fungus is a "field mold") the 1954 samples exhibited 100-400 times less fungus activity than samples from the other two years.

The frequency of occurrence of the different fungi as dominants or co-dominants in Table 1 indicates that both qualitatively and quantitatively the fungus flora responsible for deterioration is approximately the same for the years 1952 and 1953.

The role of the fungi involved in deterioration.

Table 3 gives the total counts and total recordings for the 3 years. Data from all three tables indicate that the species belonging to the Aspergillus glaucus group were the most important deteriorators of the stored corn samples tested. They were more numerous than all other species together, both in frequency of occurrence as dominants and co-dominants and on the basis of total mold counts per gram of corn. Frequency of occurrence in Table 1 indicates A. ruber was undoubtedly the most ubiquitous species of the group. However, considering total mold counts and average mold counts per occurrence, A. ruber does not appear to be as significant in the deterioration process as some of the other species of the A. glaucus group, notably A. restrictus, A. chevalieri var. intermedius, and perhaps A. amstelodami. This conclusion,

Table 2. Mold counts in 256 samples of stored corn from three harvest years, expressed for each species as the summation of counts in all positive recordings.

Species	Mold counts in thousands 1952	1953	1954	Total Count
*A. restrictus	19,912.4	102,167.5	--	122,079.9
A. candidus	11,343.8	81,438.3	13.2	92,795.3
Penicillium spp.	16,409.2	51,457.8	30.9	67,897.9
P. cyclopium	6,482.5	30,698.4	501.4	37.682.3
*A. ruber	6,236.7	29,825.6	90.0	36,152.3
*A. chevalieri var. intermedius	13,289.4	15,902.0	3.8	29,195.2
*A. amstelodami	3,216.5	23,664.4	2.8	26,883.7
*A. chevalieri	195.4	18,546.8	3.4	18,745.6
Candida sp.	1,492.7	8,443.4	11.0	9,947.1
A. flavus	1,503.2	4,962.6	182.7	6,648.5
*A. umbrosus	66.8	3,121.1	--	3,187.9
*A. repens	3,574.6	948.3	8.6	4,531.5
F. moniliforme	32.0	395.1	3,336.2	3,763.3
P. viridicatum	263.6	2,367.9	--	2,631.5
A. versicolor	138.1	2,311.5	1.4	2,451.0
Absidia sp.	511.6	--	20.3	531.9
Mucor sp.	--	--	23.0	23.0
A. niger	--	15.9	--	15.9
Total	84,668.5	376,266.6	**892.5	**461,827.6

** Excluding F. moniliforme
* Aspergillus glaucus group

however, assumes that variations in sporulation between species of this group reflect differences in vegetative growth and not merely differences in ability to sporulate within the kernel; this relationship will be considered more fully later.

Aspergillus candidus while reported in fewer samples than most of the other primary deteriorators is particularly noteworthy because of its high average mold count per occurrence shown in Table 3. Thus A. candidus has a high deterioration potential under suitable conditions. On the basis of low frequency of occurrence as a dominant or co-dominant accompanied by a fairly high average count, A. flavus is in the same category as A. candidus. A. flavus, however, would seem to have the lesser deterioration potential both on the basis of frequency of occurrence and average mold counts.

Penicillium cyclopium proved to be the most important single species of Penicillium responsible for deterioration in these studies with P. viridicatum being the next most frequent species. A number of other species

Table 3. Total mold counts per gram, number of recordings and average mold counts per occurrence for the important species of molds in 256 top samples of stored corn.

Species	Total counts in thousands	Number of recordings	Average mpg** per recording in thousands
A. candidus	92,795.3	21	4,418.8
*A. restrictus	122,079.9	48	2,543.3
Penicillium spp.	67,879.9	54	1,257.0
*A. chevalieri var. intermedius	29,195.2	25	1,167.8
P. cyclopium	37,673.3	53	710.8
*A. amstelodami	26,883.7	39	689.3
*A. chevalieri	18,745.6	28	669.5
A. flavus	6,648.5	13	511.4
*A. ruber	36,152.3	87	415.5
Candida sp.	9,947.1	25	397.9
A. versicolor	2,451.0	8	306.4
P. viridicatum	2,631.5	10	263.2
*A. repens	4,531.5	18	251.8
*A. umbrosus	3,187.9	22	144.9
Absidia repens	531.9	4	132.9

* Aspergillus glaucus group.
** Molds per gram.

of Penicillium were reported as being more or less significant in the deterioration process; these have been lumped together under the heading Penicillium spp. and include P. frequentans, P. martensii, P. variabile, P. oxalicum, and P. palitans, among occasional others. The high frequency of P. cyclopium in all three years suggests a wide latitude of conditions suitable for deterioration by this species and its high average count would indicate a high deterioration potential.

Fusarium moniliforme is fairly low in its occurrence in the highly deteriorated corn of 1953 and 1952. Its rare association with deteriorated corn indicates that it is of little significance in the spoilage of corn in the bins. This species is the most frequent fungus in 1954 corn; apparently conditions in 1954 were favorable for the development of Fusarium ear-rot in the field, which accounts for the high frequency and high counts in these samples. Conditions favorable for the development of ear-rot in the field might also account for the high frequency of P. cyclopium in 1954 corn.

On a qualitative basis, a number of fungi commonly present in analyses on the same samples by other methods (6) are not present in analyses made using the present techniques. Notable among these are Diplodia zeae, Chaetomium spp., and Microascus spp. to which the medium or the techniques involved are apparently unsuited. Since none of these

fungi were regarded as serious deteriorators of corn, no attempt was made to modify the technique to establish their relative importance on the basis of mold counts.

DISCUSSION

Almost all of the species listed in Table 1 were dominant in one or another of the samples tested. Thus, when conditions are suitable, any of these fungi might have the major responsibility in deterioration of the grain. It is more usual, however, for several fungi to be active as co-dominants in the majority of deterioration complexes. The frequency of a species as a dominant or co-dominant in a wide variety of samples is perhaps a good measure of physiological latitude of the species, particularly with respect to its moisture requirements and CO_2 tolerance. The A. glaucus group, and particularly A. ruber, is outstanding in this regard. Again, average molds per gram per occurrence might be a good criterion for deterioration potential of the different species. On this basis A. candidus and A. restrictus are extremely important, as indicated in Table 3. A. candidus, however, seems more limited in its scope than A. restrictus and the other primary storage molds because of its more exacting physiological requirements as evidenced by its less frequent occurrence as a dominant or co-dominant.

The A. restrictus series is comprised of the slow-growing members of the A. glaucus group. They differ from the other members of the group in that they do not produce cleistothecia but they are included here by Thom and Raper (8) because of certain physiological and morphological similarities to other A. glaucus group species.

Members of this series were first recorded as causing deterioration of grain in storage in 1955 by Tuite and Christensen (7). Working with stored barley, these workers found that at moisture contents from 13.8 to 14.2% there was a slow, gradual increase in the presence of seeds yielding a slow-growing subspecies of the A. glaucus group which they placed tentatively in the A. restrictus series. In a later paper Christensen (3) noted that A. restrictus also invaded seeds of various wheats stored at moisture contents of 13.5 - 15% for sixteen months. Christensen noted that the presence of A. restrictus was difficult to detect in seeds because the fungus grew poorly or not at all on normal culture media. Christensen suggested using media containing 10 - 20% sodium chloride for detection of this fungus.

Prior to the present work A. restrictus has never been recorded as occurring in stored corn. In the present study it is the third most important species, taking frequency of occurrence as the criterion; on the basis of total mold counts it is easily the highest of the A. glaucus group and would seem to be one of the primary deteriorators of stored corn in Iowa.

A. niger, frequently regarded as a storage mold of some importance, is notable by its absence as a dominant in these studies and only once recorded in measurable quantities. It is possible that A. niger is a poor sporulator under the restricted environment of the corn kernel. Koehler (5) noted that A. niger fails to establish itself in corn with less than

18.3% moisture, and that much higher moistures were required for active growth. Thus it would appear that when conditions are not longer limiting for the growth of A. niger the primary molds would already have become well established. In the CCC bins from which the samples were taken, it is the practice to stir the upper grain layers at intervals to distribute accumulated moisture, a practice which would also tend to create conditions unfavorable to the development of A. niger. Stirring may also account for the low frequency of occurrence of A. flavus which is also regarded as a high moisture mold.

The major difficulty in the interpretation of these data, and all quantitative data of this nature, is that it is not at present possible to establish the true relationship between sporulation and growth. It may be largely sporulation which is being measured by these counts, but it is the growth accompanying the sporulation which is responsible for the observed deterioration. While sporulation must be a function of growth, this relationship is bound to fluctuate between species according to habit and within species according to strain differences and environmental effects. All the storage molds have been found to fruit more or less actively within the kernel, particularly in the embryo region, but also to some extent in endosperm cavities. Thus, on the basis of casual observation, there seems little difference in the fruiting abilities of A. candidus, A. restrictus, and P. cyclopium on the one hand and A. flavus, P. viridicatum, and A. umbrosus on the other hand. This would indicate that the observed differences between these two groups of species on the basis of frequency of occurrence and total mold counts may be more related to their true differences as deteriorators than they are to their relative ability to sporulate. Experiments are in progress to establish the relative fruiting abilities of the different species within the kernels.

SUMMARY

1. A technique is outlined for the quantitative estimation of mold flora associated with the deterioration of stored corn in Iowa.

2. Two hundred and fifty-six samples of corn, representing three harvest years from 95 counties in Iowa, were processed by this technique in the summer of 1956.

3. Collections of 1953 corn rated as moldy had significantly higher mold counts than 1952 corn with the same rating, despite the fact that the latter had been stored one year longer.

4. The composition of the fungus flora responsible for deterioration is approximately the same for the two years.

5. The Aspergillus glaucus group appears to contain the most important species of deteriorating stored corn in Iowa, both on the basis of frequency of occurrence as dominants and co-dominants, and on total counts. A. ruber was the most ubiquitous species of the group but A. restrictus, A. chevalieri var. intermedius and perhaps A. amstelodami were probably more important in deterioration.

6. Approximately 25% of the counts were due to species of Aspergillus other than A. glaucus of which A. candidus was the most important single species.

7. Approximately 25% of the total counts were due to Penicillium spp. of which P. cyclopium was the most important single species.

8. Excluding species of the genera Aspergillus and Penicillium only Candida sp. appeared responsible for any serious deterioration.

LITERATURE

1. Bottomley, R.A., C.M. Christensen, and W.F. Geddes. 1952. Grain storage studies. X. The influence of aeration, time and moisture content on fat acidity, non-reducing sugars, and mold flora of stored yellow corn. Cereal Chem. 29:53-64.
2. Christensen, C.M. 1946. The quantitative determination of molds in flour. Cereal Chem. 23:322-329.
3. _____. 1955. Grain storage studies. XXI. Viability and moldiness of commercial wheat in relation to the incidence of germ damage. Cereal Chem. 32:507-518.
4. _____ and Dorothy R. Gordon. 1948. The mold flora of stored wheat and corn and its relation to heating of moist grain. Cereal Chem. 25:40-51.
5. Koehler, B. 1938. Fungus growth in shelled corn as affected by moisture. Jour. Agric. Res. 56:291-307.
6. Lichtwardt, R. W., G. L. Barron, and L. H. Tiffany. 1958. Mold flora associated with shelled corn in Iowa. Iowa State Coll. Jour. Sci. 33:1-11.
7. Tuite, J.F. and C.M. Christensen. 1955. Grain storage studies. XVI. Influence of storage conditions upon the fungus flora of barley seed. Cereal Chem. 32:1-11.
8. Thom, C. and K.B. Raper. A Manual of the Aspergilli. Williams and Wilkins Co., Baltimore, Maryland.

IOWA STATE JOURNAL OF SCIENCE
Vol. 34, No. 2 November 15, 1959 pp. 157-162

THE EFFECT OF SOME ORGANIC COMPOUNDS ON THE RATE OF THE FE(II) - FE(III) EXCHANGE[1]

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INTRODUCTION

The exchange reaction between Fe(II) and Fe(III) in perchloric acid solutions has been the subject of several investigations (1, 2, 3). This reaction may be studied by using radioactive tracer iron and following the radioactive exchange: $\overset{*}{Fe}^{+++} + Fe^{++} \rightarrow \overset{*}{Fe}^{++} + Fe^{+++}$. Silverman and Dodson (1) found the reaction to be second order over-all and first order with respect to the total concentration of each oxidation state. The over-all rate constant of the reaction in perchloric acid solutions was found to be a linear function of the reciprocal of the acid concentration.

Much work has been done on the effect of various anions on electron exchange reactions in addition to the ferrous-ferric reactions. Duke and Pinkerton (4) found the expression for the rate of exchange between ferric iron and stannous tin to be fourth order in total chloride concentration. Much of this work was done using simple anions such as the halide ions and pseudo-halide ions (e.g. CN^-, etc.).

The present work presents a study of the effects of some potential organic catalysts on the rate of exchange between ferrous and ferric iron in 1f perchloric acid.

EXPERIMENTAL

Materials:

Perchloric acid (70% vacuum distilled) purchased from J. T. Baker Chemical Company was standardized by titration with standard sodium hydroxide. It gave negative tests for chloride.

Ferric perchlorate obtained from G.F. Smith Chemical Company was used directly to prepare a stock solution of 0.069f ferric perchlorate in 1.50f perchloric acid.

A ferrous perchlorate stock solution was prepared by dissolving electrolytic iron in dilute perchloric acid. The resulting solution was

[1] Contribution No. 781. Work was performed in the Ames Laboratory of the U.S. Atomic Energy Commission.

approximately 0.2f ferrous perchlorate in 2f perchloric acid and generally less than 10^{-3}f in ferric perchlorate as determined by titration with sulfatoceric acid. The acid concentration of the ferrous perchlorate stock solution was determined by passing an aliquot of the solution through a cation exchange resin column and subsequently titrating with standard sodium hydroxide. This gave the total perchlorate concentration. Another aliquot was passed through a Jones reductor and titrated immediately with sulfatoceric acid to determine the total iron concentration. Finally, another aliquot was titrated directly with sulfatoceric acid to determine the ferrous iron concentration. The perchloric acid concentration was calculated from the titer containing these three quantities.

Radioactive iron^{59} was obtained from the Oak Ridge National Laboratory. Periodically aliquots of this sample were combined with a predetermined amount of the ferric perchlorate stock solution to give a desired concentration for a particular series of runs.

Procedure:

The reaction was run in a 250 ml Erlenmeyer flask. The flask containing the radioactive ferric fraction was partially immersed in a constant temperature bath. The ferrous fraction was prepared in a separate 125 ml Erlenmeyer flask. The concentrations of the two fractions were nearly the same with respect to all components in any particular run. This was done to minimize any possible effects of mixing. When an organic compound was used it was incorporated into the ferrous fraction.

The reaction was started by rapidly pouring the ferrous fraction into the reaction flask after both fractions had been brought to a constant temperature ($\pm 0.2^\circ$ C) in the bath. The contents of the reaction flask were stirred by a motor-driven glass propeller. At measured intervals an aliquot of 20 ml was withdrawn from the reaction vessel with a 20 ml pipette affixed to a 30 ml hypodermic syringe. With this arrangement samples could be withdrawn and discharged quite rapidly. The aliquot was immediately discharged into a 100 ml beaker which contained 10 ml of dipyridine solution and 10 ml of saturated sodium acetate solution. These amounts were previously determined so as to result in a solution of about pH 5 after the aliquot from the reaction vessel was added. The function of the dipyridine solution was to render the ferrous fraction inert to exchange processes by the formation, rapid at this pH, of the intensely red and highly stable ferrous tris 2, 2' dipyridyl ion.

The ferric iron was then precipitated as iron(III) hydroxyquinolate by adding 10 ml of 8-hydroxyquinoline solution. Because of the low reactant concentrations, an aliquot of inactive ferric perchlorate solution was added following precipitation to increase the mass of the precipitate. The precipitate was filtered, washed, vacuum dried, weighed, mounted on cards, and covered with cellophane. The samples were counted using an end window Geiger-Müller tube connected to a Berkeley 100 Decimal Scaler.

During each run eight aliquots were analyzed. The first six usually were withdrawn within three half-lives at measured intervals of between one hundred and three hundred seconds. The last two were "infinite" time samples which were withdrawn after at least ten half-lives had elapsed; these two samples generally agreed within 4%.

RESULTS AND DISCUSSION

During the preliminary stages of this work, the over-all order of the exchange process was found to agree with that obtained by Silverman and Dodson (1). The time dependence of the fraction of activity exchanged was found to follow the expression:

$$\ln \frac{{}^{*}Fe^{+++} - {}^{*}Fe^{+++}_{\infty}}{{}^{*}Fe^{+++}_{o} - {}^{*}Fe^{+++}_{\infty}} = -R \frac{[Fe^{+++}] + [Fe^{++}]}{[Fe^{+++}]\ [Fe^{++}]}\ t \ ,$$

where the terms ${}^{*}Fe^{+++}_{o}$, ${}^{*}Fe^{+++}$, and ${}^{*}Fe^{+++}_{\infty}$ represent the specific activity of the ferric fraction at time equal to zero, time t, and "infinite" time, respectively. If F represents the quantity in the logarithmic term, a plot of ln F versus time gives a straight line whose slope is $-R \frac{[Fe^{+++}] + [Fe^{++}]}{[Fe^{+++}]\ [Fe^{++}]}$. Such a graph is given in Fig.1. The intercept is zero after correction for zero time exchange. The zero time exchange represented by $(1-F_o)$ 100 averaged nearly 60%. If this exchange is reproducible it has no effect on the slope of the lines and only causes variation of the intercept.

When organic compounds such as benzoquinone, pyrazine, and p-phthalic acid were introduced into the system it was thought that catalysis of the reaction might be observed. Catalysis would be the result of the formation of a bridge-type structure which would enhance the transference of an electron. However, it was found that benzoquinone at concentrations comparable to those of the reactants caused no increased rate of exchange. Pyrazine at concentrations comparable to those of the reactants and as high as 0.25f did not affect the rate of exchange.

The introduction of p-phthalic acid into the system caused a marked increase in the exchange rate as shown in Fig.1. Because of the very low solubility of p-phthalic acid in 1f perchloric acid, the concentration of the p-phthalic acid was not varied. Table 1 summarizes the results.

Taube (5) used the phthalic acids as electron mediators in the reaction of $(NH_3)_5Co^{III}L$ and Cr^{++} where L represents the anion of the acid in solution. Taube found that the para isomer increased the rate considerably while there was a relatively large decrease in catalytic effect when m-phthalic acid was used. The effect caused by o-phthalic acid was very small, probably due to structural hindrances. Analogously, the ferrous-ferric reaction should show the greatest increased rate of exchange with p-phthalic acid.

One may conclude from the present work that p-benzoquinone and pyrazine fail to form complexes with either Fe(II) or Fe(III) or both, but that p-phthalic acid does form a bridged complex. No runs were made with the meta or ortho isomers of phthalic acid. However, one would predict the same decreased catalysis when the para, meta, and ortho isomers are used, respectively, in the ferrous-ferric iron exchange reaction.

Table 1

Compound L	Conc. of L f x 10^4	Conc. of Fe^{+++} f x 10^4	Conc. of Fe^{++} f x 10^4	Conc. of $HClO_4$ f	Temp. °C	Catalysis
Benzoquinone	2.5	2.7	2.7	0.51	±0.2	none
Pyrazine	5.0	5.0	5.0	1.00	±0.2	none
	2.5 x 10^3	2.5	4.7	1.00	±0.2	none
p-Phthalic Acid	<10	2.5	4.7	1.00	±0.2	40%

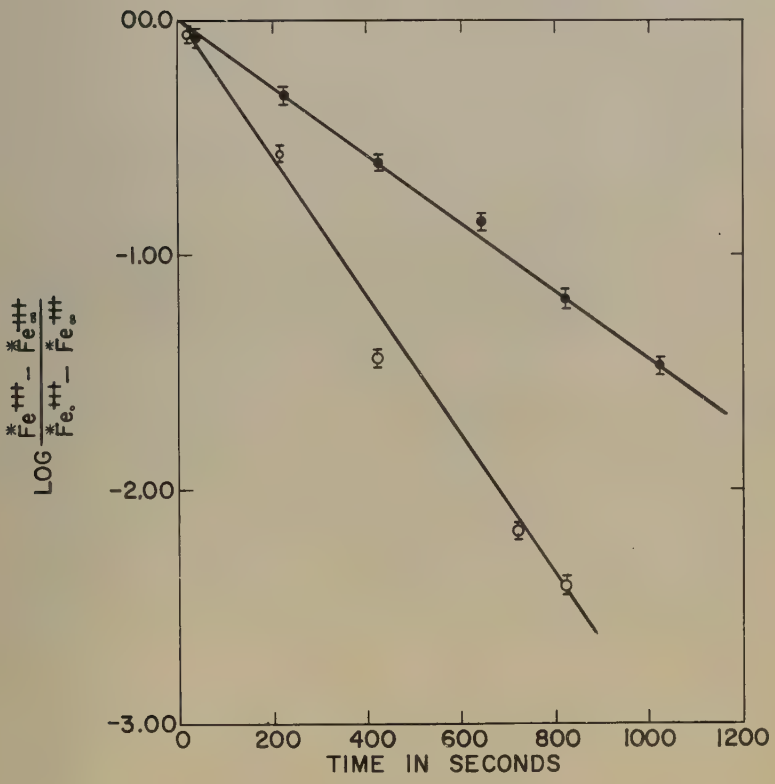

Fig. 1. ● no organic catalyst

○ p-phthalic acid

REFERENCES

1. Silverman, J. and R.W. Dodson. 1952. The exchange reaction between the two oxidation states of iron in acid solution. J. Phys. Chem. 56:846.
2. Linnenborn, V.J. and A.C. Wahl. 1949. Exchange reactions between cerium(III) and cerium(IV) and between iron(II) and iron(III). J. Am. Chem. Soc. 71:2589.
3. Betts, R.H. and H.S.A. Gilmour and K. Leigh. 1950. Electron transfer between ferrous and ferric ions in perchloric acid s solutions. J. Am. Chem. Soc. 72:4978.
4. Duke, F.R. and R.C. Pinkerton. 1951. The role of halide ions in the ferric-stannous reaction. J. Am. Chem. Soc. 73:3045.
5. Taube, H. and D.R. Sebera. 1958. To be published. Taken from preprints of papers: Bridging and non-bridging ligand effects in redox reactions of metal ions." Symposium on Charge Transfer Process, University of Toronto (September 4-5, 1958).

IOWA STATE JOURNAL OF SCIENCE
Vol. 34, No. 2 November 15, 1959 pp. 163-174

SOME REACTIONS OF GELSEMINE

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Abstract

Various reactions mainly of the vinyl and oxindole functions of the alkaloid gelsemine are described. Two new methods for opening the oxindole ring are portrayed. The biosynthesis of the alkaloid is discussed.

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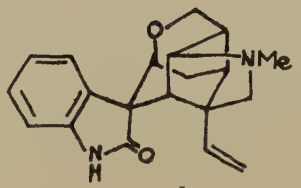
Prior to the recent X-ray determination of the structure of gelsemine (1) and the presentation of chemical and NMR evidence in conformity with this structure (2) experiments were under way in this laboratory designed to penetrate the then mysterious hexacyclic nucleus of this major alkaloid of Gelsemium sempervirens, Ait. Whereas many routes of degradation failed, mainly because of the amazing lack of crystallinity of many derivatives, some reactions shed some light on the functional groups of the alkaloid while others opened degradative pathways possibly useful in structure determinations of other oxindole alkaloids. The following discussion will be based on the now established structure I (1, 2) for gelsemine.

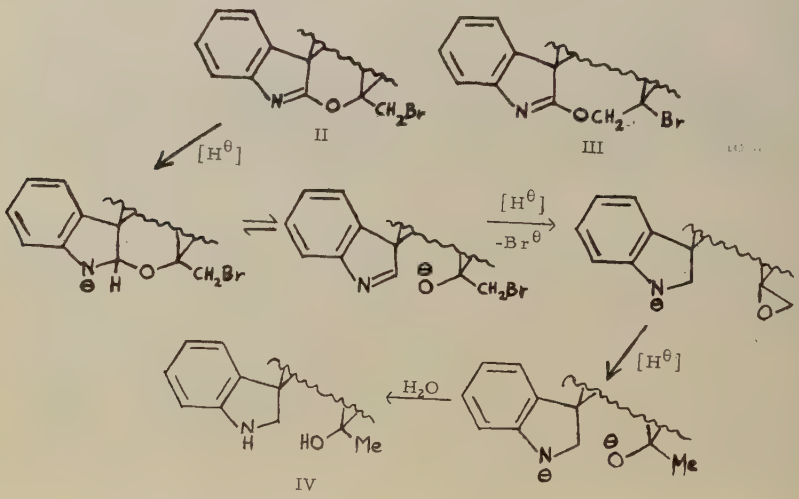


I

The Vinyl Group.

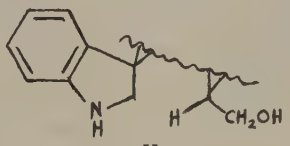
Early hydrogenation studies (3) revealed the presence of one olefinic linkage in gelsemine. Its location on a terminal methylene group was established by the absence of a C-methyl group in the alkaloid but its presence in the dihydro derivative (4) and by the formation of formaldehyde in the ozonization (5) (an ambiguous result in view of the presence of an equally vulnerable N-methyl group) as well as Lemieux oxidation (6) of the alkaloid. More recently the double bond was shown to be a vinyl group (7, 8), attached to a quaternary carbon atom (9).

Bromination of gelsemine resulted in an internal interaction between the oxindole and olefin functions leading to a substance to which part structure II was assigned (5). While the reaction clearly revealed the proximity of the two functional groups and II is in consonance with the now established structure of the alkaloid, formulation II in preference to the non-Markovnikov addition picture III was premature in the absence of specific knowledge about the closeness of the two groups and the steric environment of the olefinic group. Lithium aluminum hydride reduction of II led to an indoline alcohol which was considered to be IV (5). The probable route of this multi-step reduction is illustrated below.



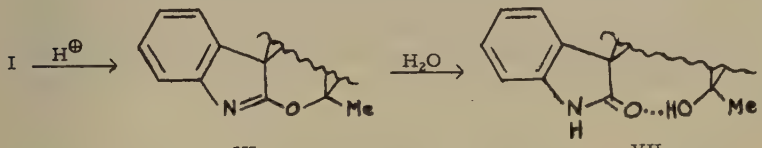
Prior to the revelation of the exact nature of the olefinic linkage in gelsemine, at a time when, in fact, it was considered to be a 1,1-disubstituted double bond, $R_2C = CH_2$, we were interested in exposing the alkaloid to degradation at this reactive site. Since oxidation by various means led to no recognizable products, compound IV was investigated. While again no crystalline products were obtained, the reactions could be followed by infrared spectroscopy. Easy N- as well as O-acetylation rapidly revealed that IV could not be a tertiary alcohol. This implied that either the structure of IV was incorrect and, hence, the hydride reduction misinterpreted or the double bond in its precursor was only monosubstituted. The former alternative seemed more likely when it could be shown that mild base hydrolysis to the acetamido alcohol, followed by chromic acid oxidation yielded an acidic product. Final proof of the incorrectness of the structure of IV came when a Kuhn-Roth oxidation gave a negative C-Me determination. As a consequence, the hydride reduction product must be reformulated as V (10). The lithium aluminum hydride reduction of the intermediate epoxide (vide supra) must have preceded by a 1,2-hydride shift and reduction of the resultant aldehyde,

a process which now has ample analogy (11).



V

Treatment of gelsemine with hydrochloric, hydrobomic or hydroiodic acids has been reported to yield the hydration products apogelsemine and isoapogelsemine as well as a haloisoapogelsemine (12, 13). Each of the halo compounds was convertible into isoapogelsemine (12, 13), while zinc reduction of one of them, iodoisoapogelsemine, has yielded dihydrogelsemine (13). These facts are best interpreted on the basis of all products being unrearranged addition compounds. This view was strengthened when, on repetition of a hydrochloric acid treatment of gelsemine, the infrared spectra of the crude reaction mixture and the purified products were inspected. The crude mixture consisted largely of the imino ether, allogelsemine (VI). As a consequence, apogelsemine (VII), the major product, undoubtedly arises from a simple hydrolysis of the imino ether linkage. Both this substance and the epimeric alcohol, isoapogelsemine (VII), exhibited OH absorption only at 3.0 μ, characteristic of hydrogen-bonded hydroxyl groups. These data were further corroboration of the propinquity of the hydroxyl and oxindole carbonyl groups.

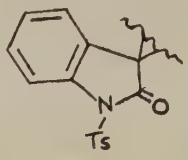


VI VII

When, in an attempt to obtain hydrated products without an accompanying halo compound, gelsemine was treated with refluxing 20% sulfuric acid for 19 hours, a new apo compound A was isolated. It was converted into B by sublimation or by attempted Oppenauer oxidation. Compound B could be obtained directly from gelsemine by a similar sulfuric acid treatment for 65 hours. While neither A nor B were identical with apogelsemine or isoapogelsemine, they were presumably isomers of the latter. This could be assured of B by analysis, but only conjectured about A, a compound which along with its derivative resisted all efforts of purification. Undoubtedly, these substances were Wagner-Meerwein rearrangement products. Compound A possessed a nonhydrogen-bonded hydroxyl group and formed an O-acetate. However, B showed strong hydrogen bonding between the hydroxyl and oxindole carbonyl groups and was converted readily to an O, N_a-diacetate. Formation of the latter is in sharp contrast to the strong resistance of gelsemine toward N_a-acetylation (5). Various attempts of oxidation of compounds A and B led to indefinite results.

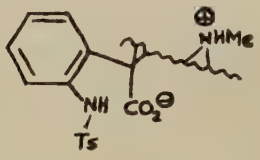
The Oxindole Moiety.

Another entry into the center of the polynuclear structure of gelsemine appeared to be via the oxindole unit. If the latter could be ruptured, in principle a path might be found for complete removal of this moiety. Since the oxindole lactam had been found to be exceedingly resistant to hydrolysis (13), it had to be altered in a manner that would make the carbonyl group more vulnerable to nucleophilic attack and make the resulting o-aminophenylacetic acid system more stable. Both these features could be predicted for and, indeed, were found in N_a-tosylgelsemine (VIII). The latter was formed in a manner analogous to the reported synthesis of N_a-methylgelsemine (14). The crystalline derivative exhibited its carbonyl peak in the infrared spectrum at an expected lower wavelength, 5.70 μ. It readily formed a methiodide, which on attempted Hofmann degradation under various conditions yielded no characterizable products.

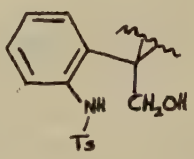


VIII

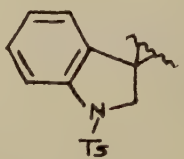
Whereas tosylgelsemine (VIII) was stable toward dilute acid, it was converted easily by base into an amino acid (IX). The latter reverted to tosylgelsemine (VIII) on treatment with 50% sulfuric acid at room temperature. Lithium aluminum hydride reduction of VIII yielded the amino alcohol (X), rather than N_a-tosyldihydrodesoxogelsemine (XI), a substance which was prepared by tosylation of dihydrodesoxogelsemine. Thus, two different schemes for opening the oxindole moiety of the alkaloid had been found.



IX



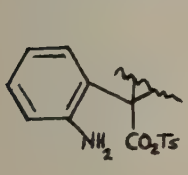
X



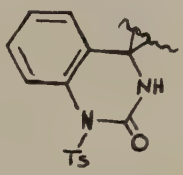
XI

When the amino acid (IX) was refluxed in an ethylene glycol solution of sodium hydroxide, it reverted to gelsemine (I). The ease of this dehydrative detosylation can be accounted for by assuming a prior intramolecular N-to-O transtosylation and internal amination of the resulting mixed anhydride (XII). Exposure of IX to concentrated sulfuric acid and hydrazoic acid, in an attempted Schmidt reaction, led to a noncrystalline mixture of tosylgelsemine (VIII) and presumably the cyclic urea (XIII). Unfortunately, separation of the latter and, hence, its structure proof failed. Treatment of IX with iodine and sodium bicarbonate yielded an amorphous substance, assumed to be iodolactone XIV. Its 5.77μ infrared

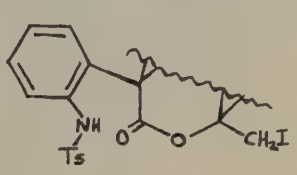
carbonyl peak indicated it to be a δ-lactone, a ring of a size now to be expected on the basis of the accepted structure I for gelsemine.



XII

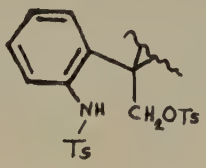


XIII



XIV

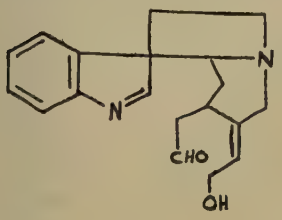
An attempt to convert the α,α-disubstituted β-(o-tosylamidophenyl-)-ethanol X to its corresponding styrene by treatment with formic acid led to unidentifiable products. Likewise, solvolysis of its tosylate (XV), prepared by lithium aluminum hydride reduction of tosylgelsemine (VIII) and tosylation of the unseparated reaction mixture, met with failure. Similar reactions with products derived from dihydrogelsemine led to no more success.



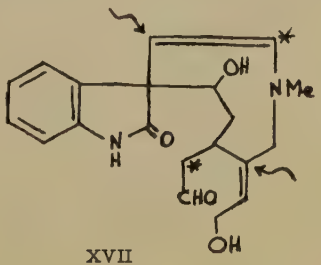
XV

Biosynthesis of Gelsemine.

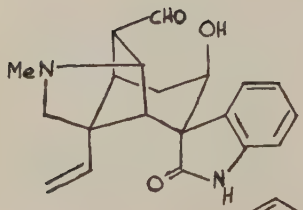
In a brilliant exposition of biosynthetic theory Woodward was able to derive the structure of gelsemine prior to its complete elucidation (1, 15). By analogy with the biosynthesis and some structural patterns of the strychnos alkaloids the biosynthetic intermediate XVI was considered to lead via several, mainly oxidative operations to XVII. An intramolecular carbon-carbon bond formation of a novel type (arrows in XVII) and another of the ajmaline type (asterisks in XVII) were envisaged to yield a hydroxyaldehyde (XVIII), which on reduction and dehydration would give gelsemine (XIX). A slight variant of this scheme, involving XX in place of XVII, has been presented by Conroy (2).



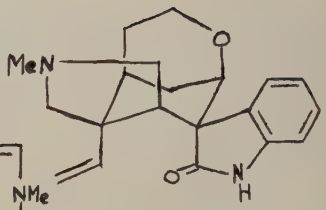
XVI



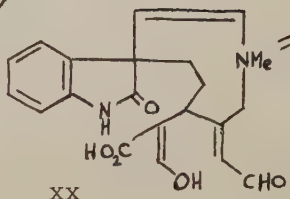
XVII



XVIII

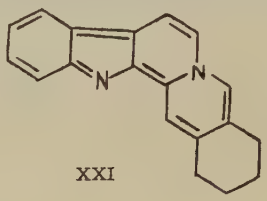


XIX

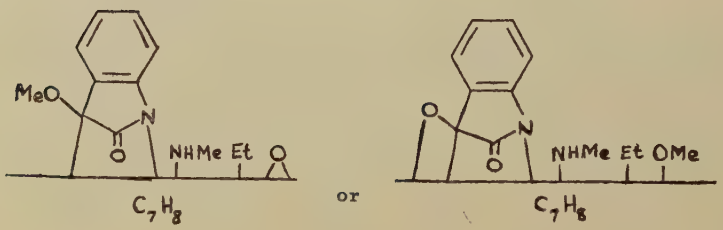


XX

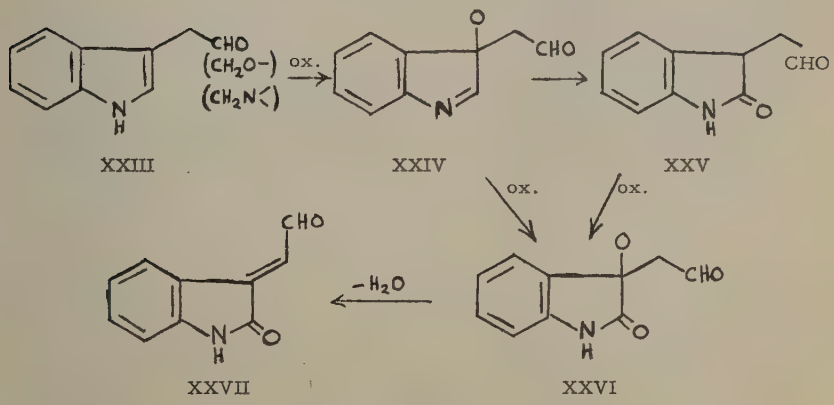
The Woodward scheme is in harmony with the recent generalized theory of alkaloid biosynthesis (16, 17), since XVI is readily derivable from tryptophyl, formaldehyde and prephenate units. It places the prephenate moiety in a state of oxidation equivalent to that in the strychnos alkaloids, but higher than in most other indole alkaloids. Inspection of the structures of sempervirine (XXI) and gelsedine (XXII) (18), two alkaloids occurring naturally side by side with gelsemine, however, suggests strongly that the oxidases in the Gelsemium plant operate mainly on the tryptophyl residue, rather than the prephanate unit. If, as a consequence, it be assumed that 3-indolylacetaldehyde (XXIII), or its tryptophol or tryptamine counterparts, may proceed through an oxidation series, involving the indolenine XXIV, oxindole XXV, or dioxindole XXVI directly, and oxindole XXVII, biosynthetic intermediates would be on hand, all of which could lead to the various Gelsemium and other oxindole alkaloids on condensation with formaldehyde-prephenate systems.



XXI



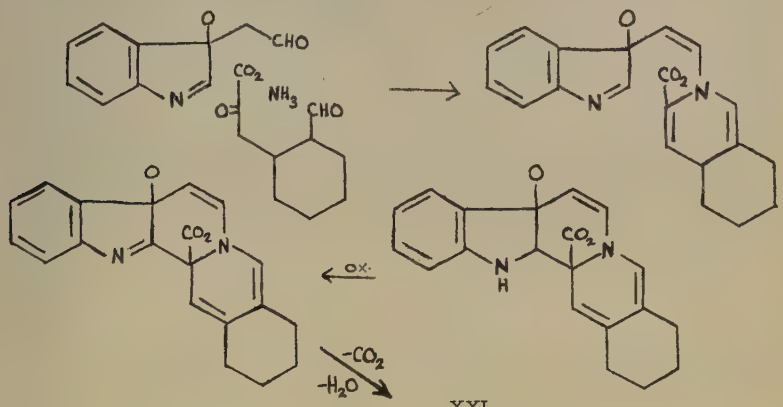
XXII



XXIII XXIV XXV

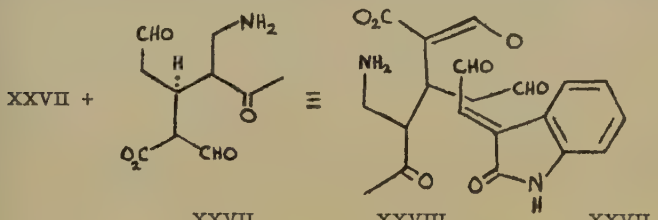
XXVII XXVI

Compounds XXIII and XXIV have the same relationship to each other as cinchonamine and quinamine. Most probably, XXIV serves as precursor of sempervirine:

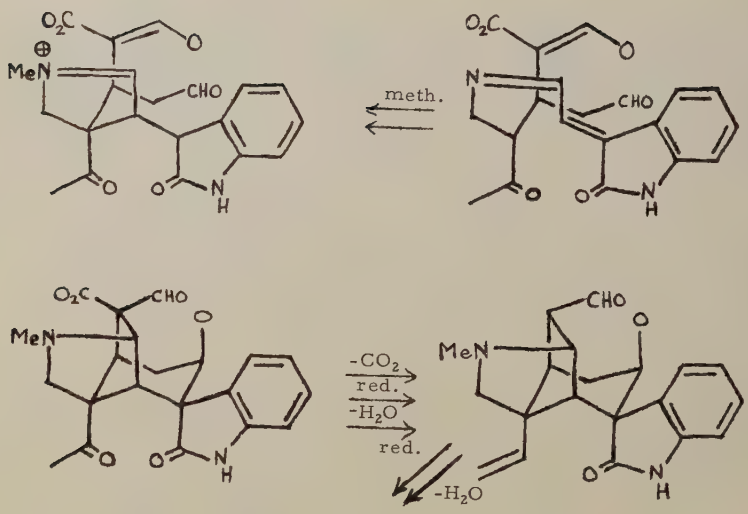


XXI

Intermediates of the type of XXV are the progenitors of rhyncophylline and similar oxindole alkaloids, while XXVI may lead to gelsedine (XXII). Finally XXVII in combination with XXVIII yields gelsemine:



XXVII XXVIII XXVII



XIX

The above as well as Woodward's suggestion requires the absolute configuration of gelsemine to be as depicted in XIX rather than I.

Acknowledgements. The authors are most grateful to the Upjohn Co. for financial support and for the extraction and isolation of gelsemine, to S.B. Penick and Co. for a sample of the alkaloid and to the Institute of Atomic Research for the use of a Baird infrared spectrophotometer.

Experimental

(Melting points are uncorrected. Ultraviolet spectra were run in 95% alcohol solutions. Optical rotations were measured at 25° in pyridine solutions.)

The Diacetate of Compound V. —A solution of 560 mg of V (Calcd. for 1 C-Me: 4.66; found: 0.54, 0.0) in 10 ml of acetic anhydride and 10 ml of pyridine was heated on a steam bath for 3 hours and allowed to stand at room temperature for 18 hours. After vacuum removal of the solvent the residue was partitioned between dilute sodium bicarbonate solution and chloroform. The organic layer was dried over magnesium sulfate, filtered and evaporated. The residue was chromatographed on neutral alumina and a major fraction, 510 mg, was eluted with 3:1 benzene-chloroform. Whereas this fraction could not be crystallized, vacuum evaporation of its chloroform solution produced a white foam, m.p. 100-105°; infrared spectrum ($CHCl_3$), C = O 5.80 (s), 6.07 (s)μ, C = C 6.28 (m)μ.

The N-Acetyl Derivative of Compound V. —A solution of 510 mg of the diacetate of V and 53 mg of sodium hydroxide in 4 ml of water and 25 ml of methanol was allowed to stand at room temperature for 21 hours. After vacuum removal of the solvents the residue was dissolved in chloroform and dilute sodium carbonate. The separated organic solution was dried, filtered and evaporated. The residue was chromatographed on alumina. Elution with 1 : 1 benzene-chloroform yielded a major fraction which could not be induced to crystallize. Drying under vacuum gave a foam, m.p. 115-120°, $[\alpha]_D$-33.6°; infrared spectrum ($CHCl_3$), OH 2.80 (w)μ, C = O 6.08 (s)μ, C = C 6.29 (m)μ.

Hydration of Gelsemine, Compound A. —A solution of 1.18 g of gelsemine, 10 ml of conc. sulfuric acid and 10 ml of water was refluxed for 19 hours. The solution was cooled, made basic with dilute sodium hydroxide and extracted in 10 portions with 1.05 liter of chloroform. The combined organic extracts were dried over magnesium sulfate, filtered and evaporated to dryness. Attempted crystallization of the residue with acetone produced 520 mg of a white powder, $[\alpha]_D$ 0.2°; infrared spectrum (nujol). OH 2.8 (m)μ, NH 3.07 (m), 3.20 (m)μ, C = O 5.89 (s)μ, C = C 6.19 (m), 6.29 (m)μ.

A solution of 150 mg of compound A, a few drops of pyridine and 1 ml of acetic anhydride was heated on the steam bath for 3 hours. After letting the solution stand in the presence of water, it was made basic with dilute sodium carbonate solution and extracted with four 40 ml portions of chloroform. The combined organic extracts were dried, filtered and evaporated. The residue was chromatographed on neutral alumina, the major fraction being eluted with 1 : 1 benzene-chloroform. It could not be crystallized from common solvents, but deposited crystals on slow evaporation from an acetone solution; m.p. 230° dec.; spectra: ultraviolet, λ_{max} 252μ (log ε 3.87) and 283 mμ (log ε 3.21); infrared ($CHCl_3$), C = O 5.80 (s), 5.86 (s)μ, C = C 6.28 (m)μ.

Compound B. — a.) When gelsemine was exposed to the conditions of hydration, which led to compound A, but for a longer reaction time, 65 hours, compound B could be isolated. Crystallization from chloroform gave an amorphous white powder. b.) Sublimation of compound A at 200° and 1μ gave B. c.) Compound B also could be obtained by refluxing for 23 hours a solution of 720 mg of gelsemine and 7.2 g of cyclohexanone in 50 ml of anhydrous benzene, to which a solution of 4 g of aluminum phenoxide in 30 ml of anhydrous benzene had been added, washing the cooled solution with water, extracting the organic products with chloroform and following with the usual work-up.

Two sublimations of B at 220° and 1μ yielded a powder, m.p. 285-287° dec. (browning at 245°), $[\alpha]_D$ 4.9°; infrared spectrum (nujol), OH 2.94 (m)μ, NH 3.08 (m)μ, C = O 5.95 (s)μ, C = C 6.21 (m), 6.31 (w)μ. When compound B was regenerated from its picrate and crystallized in chloroform, it gave small crystals, m.p. 268° dec. (browning at 248°).

Anal. Calcd. for $C_{20}H_{24}O_3N_2$: C, 70.56; H, 7.11; N, 8.23. Found: C, 69.81; H, 7.44; N, 7.82.

The picrate of B was crystallized three times from ethanol and dried under vacuum at 78° for 4 hours, m.p. 273° dec. (browning at 200°), $[\alpha]_D$ 34.8°.

Anal. Calcd. for $C_{26}H_{27}O_{10}N_5 \cdot C_2H_6O$: C, 54.63; H, 5.40; N, 11.38. Found: C, 55.01; H, 5.81; N, 11.27.

A solution of 100 mg of compound B and 2 ml of pyridine in 2 ml of acetic anhydride was heated on the steam bath for 2 hours. The reaction mixture was cooled, diluted with 30 ml portions of ether, the combined extracts dried over magnesium sulfate, filtered and evaporated and the residue crystallized twice from ether-petroleum ether. Further crystallization from ether gave white crystals, m.p. 196-198°, $[\alpha]_D$-7.7°; spectra: ultraviolet, λ_{max} 230 mμ (log ε 4.03), $\lambda_{shoulder}$ 260 mμ (log ε 3.48), 277 mμ (log ε 3.04) and 291 mμ (log ε 2.62); infrared (nujol), C = O 5.72 (s), 5.78 (s), 5.89 (s)μ, C = C 6.24 (m)μ.

Anal. Calcd. for $C_{24}H_{28}O_5N_2$: C, 67.90; H, 6.65; N, 6.60. Found: C, 68.01; H, 6.49; N, 6.54.

N_a-Tosylgelsemine (VIII). — A mixture of 3.08 g of gelsemine and 0.40 g of potassium in 100 ml of anhydrous benzene was stirred vigorously and refluxed under nitrogen for 16 hours. After addition of 1.84 g of p-toluenesulfonyl chloride in 40 ml of anhydrous benzene to the cream-colored suspension the stirring and refluxing was continued for 8 hours. A solution of 50 ml of water and 35 ml of methanol was added slowly, the mixture stirred for an hour at room temperature, the aqueous layer brought to pH 10 by the addition of sodium hydroxide and the layers separated. The organic solution was washed with water and the aqueous layer with two 50 ml portions of benzene. The combined organic extracts were dried over magnesium sulfate, filtered and chromatographed on neutral alumina. The major product was eluted with benzene, while a small amount of unreacted gelsemine was obtained from the chloroform eluates. Four crystallizations from ether gave 2.35 g (52%) of white needles, m.p. 133-135°, $[\alpha]_D$-28.4°; spectra: ultraviolet, $\lambda_{shoulder}$ 230 mμ (log ε 4.19), 289 mμ (log ε 2.85), infrared ($CHCl_3$), C = O 5.70 (s)μ, C = C 6.12 (w), 6.25 (m)μ. Concentration of the mother liquors gave an additional 1.40 g (31%) of crude product, m.p. 130-134°.

Anal. Calcd. for $C_{27}H_{28}O_4N_2S$: C, 68.05; H, 5.92; N, 5.88. Found: C, 67.98; H, 5.95; N, 6.05.

A chloroform solution of N_a-tosylgelsemine (VIII) and excess methyl iodide was refluxed for 1 hour. Removal of the solvent left a residue, which on three crystallizations from methanol yielded white flakes of crystalline methiodide, m.p. 250-252° dec., $[\alpha]_D$ 20°.

Anal. Calcd. for $C_{28}H_{31}O_4N_2SI$: C, 54.37; H, 5.05; N, 4.53. Found: C, 54.43; H, 5.37; N, 4.47.

Amino Acid IX. — A solution of 162 mg of sodium hydroxide in water was added to 500 mg of N_a-tosylgelsemine (VIII) in 40 ml of ethanol and the mixture refluxed for 22 hours. After partial concentration of the mixture it was acidified with hydrochloric acid and sodium bicarbonate added. The cloudy solution (whenever a precipitate formed, it was filtered and worked up in the following manner) was extracted with ten 60 ml portions of chloroform and the resulting solution dried over sodium sulfate. After filtration and solvent removal 450 mg (87%) of white solid was obtained, which on four crystallizations from methanol gave 250 mg of white crystals, m.p. 185-187°; spectra: ultraviolet, $\lambda_{shoulder}$ 223 mμ (log ε 4.22) and 280 mμ (log ε 3.26), infrared ($CHCl_3$), OH, $NH_2^{\oplus}$ broad 4.06-4.35(mμ, C = O 6.22(s)μ, C = C 6.30(m)μ. The analytical sample was dried under vacuum at 100° for 3 hours.

Anal. Calcd. for $C_{27}H_{30}O_5N_2S \cdot CH_3OH$: C, 63.86; H, 6.51; N, 5.32. Found: C, 63.93; H, 6.45; N, 5.50.

Concentrated sulfuric acid, 5 ml, was added to a suspension of 100 mg of the amino acid IX in 5 ml of water and the mixture allowed to stand at room temperature for 4 hours. The mixture was poured onto 15 g of ice and the slurry extracted with 175 ml of chloroform in four portions. The extracts were washed with 5% sodium carbonate solution, dried over magnesium sulfate and evaporated under vacuum. A 1:1 petroleum ether-benzene solution of the residue was chromatographed on neutral alumina, which led to a benzene eluate of 50 mg whose infrared spectrum was identical in all respects with that of N_a-tosylgelsemine (VIII).

A solution of 9.5 mg of sodium hydroxide in 2.5 ml of water was added to a solution of 50 mg of the amino acid IX in 50 ml of ethylene glycol. The mixture was distilled up to a vapor temperature of 193° and then refluxed under nitrogen for 2 hours. Thereupon the solvent was removed under vacuum, the residue dissolved in dilute hydrochloric acid (pH2) and the solution extracted with chloroform. After addition of sodium bicarbonate the aqueous solution was extracted further with four 50 ml portions of chloroform. The combined organic extracts from the neutral solution were dried over sodium sulfate, filtered and evaporated. The remaining white solid, 30 mg, had an infrared spectrum identical with that of gelsemine. Crystallization from acetone gave white crystals, m.p. 173-177°, m.m.p. 174-177° with gelsemine acetonide.

Iodolactone XIV. — A mixture of 50 mg of amino acid IX, 26 mg of iodine, and 1 g of sodium bicarbonate in 50 ml of chloroform was allowed to stand in the dark for 16 days. The colored mixture was filtered, evaporated under vacuum and the residue chromatographed on neutral alumina. Elution with 1:1 benzene-chloroform yielded an oily brown solid and an amorphous white solid whose infrared spectrum ($CHCl_3$) exhibited peaks at 2.8(w), 2.97(w), 5.77(s), and 6.27(m)μ.

Amino Alcohol X. — A mixture of 605 mg of N_a-tosylgelsemine and 45 mg of lithium aluminum hydride in 50 ml of anhydrous dioxane was refluxed for 16 hours under nitrogen. After hydrolysis with 10 ml of 90% methanol, the reaction mixture was evaporated to dryness under vacuum. The residue was dissolved in 40 ml of 5% hydrochloric acid and the solution stirred with 40 ml of chloroform while it slowly was made basic with sodium carbonate. The resulting slurry was filtered and the solid washed twice with 40 ml portions of boiling chloroform. The two phases of the combined filtrates were separated and the organic phase dried over sodium sulfate, filtered and evaporated under vacuum. The residue was crystallized six times from benzene and dried under high vacuum at 100° for 4 hours; m.p. 265-266° dec., $[\alpha]_D$-88.3°; spectra: ultraviolet, λ_{max} 221mμ ($\log \varepsilon$ 4.20) and 255mμ ($\log \varepsilon$ 3.75), λ_{min} 248mμ ($\log \varepsilon$ 3.74); infrared ($CHCl_3$), OH 2.80(w)μ, NH 3.05(w)μ. C = C 6.16(w), 6.26(m)μ.

Anal. Calcd. for $C_{27}H_{32}O_4N_2S$: C, 67.48; H, 6.71; N, 5.83. Found: C, 68.01; H, 6.38; N, 5.83.

N_a-Tosyldihydrodesoxogelsemine (XI). — A solution of 170 mg of dihydrodesoxogelsemine, m.p. 138-139° [reported (19) m.p. 137.0-137.5°], and 140 mg of tosyl chloride in 10 ml of pyridine was warmed on the steam bath for half an hour and then left standing at room temperature

for 12 hours. After the addition of 10 ml of water the mixture was concentrated and the resulting pink syrup partitioned between chloroform and dilute sodium hydroxide solution. The organic extract was dried over magnesium sulfate, filtered and evaporated to dryness. Chromatography of the residue on neutral alumina led to a solid product in the 4:1 benzene-chloroform eluates. Three crystallizations from ether yielded white needles, m.p. 153-155°, $[\alpha]_D$ -44 ; ultraviolet spectrum, λ_{max} 221mμ (log ε 4.18) and 262mλ (log ε 3.84), λ_{min} 245mμ (log ε 3.75).

Anal. Calcd. for $C_{27}H_{30}O_3N_2S$: C, 70.10; H, 6.54; N, 6.06. Found: C, 70.39; H, 6.52; N, 6.10.

LITERATURE CITED

1. Lovell, F.M., R. Pepinsky, and A.J.C. Wilson. 1959. Tetrahedon Letters 4:1.
2. Conroy, H. and J.K. Chakrabarti. 1959. Tetrahedon Letters 4:6.
3. Chu, T.T. and T.Q. Chou. 1940. J. Am. Chem. Soc. 62:1955.
4. Gibson, M.S. and R. Robinson. 1951. Chem. and Ind. 93.
5. Goutarel, R., M.-M. Janot, V. Prelog, R.P.A. Sneeden, and W.I. Taylor. 1951. Helv. Chim. Acta 34:1139.
6. Lemieux, R.U. and E. von Rudloff. 1955. Canad. J. Chem. 33:1710.
7. Marion, L. and K. Sargeant. 1956. J. Am. Chem. Soc. 78:5127.
8. _____ and _____. 1957. Canad. J. Chem. 35:301.
9. _____. 1957. Private communication.
10. Professor Prelog kindly has informed the authors that he independently has arrived at a similar conclusion.
11. Eliel, E.L. and T.J. Prosser. 1956. J. Am. Chem. Soc. 78:4045.
12. Moore, C.W. 1911. J. Chem. Soc. 99:1231.
13. Forsyth, W.G.C., S.F. Marrian, and T.S. Stevens. 1945. J. Chem. Soc. 579.
14. Witkop, B. and J.B. Patrick. 1953. J. Am. Chem. Soc. 75:2572.
15. Woodward, R.B. 1959. Private communication.
16. Wenkert, E. and N.V. Bringi. 1959. J. Am. Chem. Soc. 81:1474.
17. _____. 1959. Experientia 15:165.
18. _____ and J.C. Orr. 1959. Unpublished data.
19. Kates, M. and L. Marion. 1951. Canad. J. Chem. 29:37.

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PUBLICATIONS OF MEMBERS OF THE STAFF OF THE IOWA STATE UNIVERSITY FOR THE ACADEMIC YEAR 1958-59

Certain summaries and indices are of interest in a survey of the publications of members of the staff of an educational and research institution such as the Iowa State University. The publications are listed in alphabetic order under the names of the senior authors. Junior authors are also listed alphabetically with cross reference to senior author.

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AUTHORS AND PUBLICATIONS

1. Aaes-Jørgensen, Erik, E.E. Leppik, H.W. Hayes and R.T. Holman. Essential fatty acid deficiency. II. In adult rats. Jour. Nutr. 66(2): 245-259. 1958.
2. Abrams, R. and K.J. Frey. Effect of recurrent x-radiation on germination and seedling vigor in oats. Proc. Iowa Acad. Sci. 65:174-183. 1958.
3. Acker, R.F., P.A. Hartman, J.R. Pemberton and L.Y. Quinn. The nutritional potential of poultry offal. Poultry Sci. 38:706-711. 1959.

Adams, C.I., joint author. See under Banks.

Adams, W.H., joint author. See under Spedding.

Ahrens, J.F., joint author. See under Melhus.

4. Aikman, J.M. Prairie research in Iowa. Amer. Biol. Teacher. 21: 9-11. 1959.

_____, joint author. See under Hendrickson.

5. Aldinger, S.M., V.C. Speer, G.C. Ashton, V.W. Hays and D.V. Catron. Effect of feeding different combinations of soft phosphate with collidal clay and dicalcium phosphate with and without added fluorine for growing-finishing swine. Jour. Animal Sci. 18:555-560. 1959.
6. Aldrich, P.E., P.A. Diassi, D.F. Dickel, C.M. Dylion, P.D. Hance, C.F. Hubner, B. Korzun, L.H. Liu, H.B. MacPhillamy, E.W. Robb, D.K. Roychaudhuri, E. Schlittler, A.F. St. André, E.E. van Tamelen, F.L. Weisenborn, E. Wenkert and O. Wintersteiner. The stereochemistry of reserpine, deserpidine and related alkaloids. Jour. Amer. Chem. Soc. 81:2481-2494. 1959.

Allen, R.S., joint author. See under Bush, Foreman, Frape, Ratcliff.

7. Allenspach, Allan L. and Howard L. Hamilton. Closure and reopening of the esophagus in the chick. The Anatomical Record. 134:525. 1959.
8. Allos, H.F. and W.V. Bartholomew. Replacement of symbiotic fixation by available nitrogen. Soil Sci. 87:61-66. 1959.

Almfeldt, M.W., joint author. See under Rising.

Alsmeyer, W.C., joint author. See under Harrenstien

9. Altman, L.B., Jr. and L.F. Charity. Heating houses electrically. Iowa Farm Science 13(4):8-10. 1958.
10. _____, _____. Diversity of farm loans. Applications and Industry, AIEE Transaction Papers. pp. 439-443. Nov., 1958.
11. _____, _____. Report on Iowa electric house-heating study - 1958. U.S. Dept. of Agric., Agricultural Research Service Bull. ARS-42-28. 12 pp. May, 1959.
12. Amma, E.L. and R.E. Rundle. Electron deficient compounds. VIII. The crystal and molecular structure of trimethylindium. Jour. Amer. Chem. Soc. 80:4141-4145. 1958.
13. Anderson, G.S. and S. Legvold. Conduction electron-magnetic ion interaction in rare earths. Phys. Rev. Letters. 1:1-2. 1958.
14. _____, _____ and F.H. Spedding. Hall effect in Lu, Yb, Tm, and Sm. Phys. Rev. 111:1257-1258. 1958.
15. Anderson, J.H. and K.K. Barnes. Electrical power transmission and loan analysis for a combine. Ia. Agr. and H. Economic Exp. Sta. Spec. Report. No. 23. 20 pp. 1958.

Anderson, L.L., joint author. See under Day.

16. Anderson, M.A. and E.T. Hibbs. Electrometric and biological evaluations of Thimet residues in greenhouse chrysanthemums. Ent. Soc. Amer., North Central Branch Proc. 14: 1959.

STAFF MEMBER PUBLICATIONS, 1958-59

17. Anderson, P.M. Recent improvements on the A-C network analyzer. Proc., 21st. Ann. Amer. Power. Confer. 1959.
Aoki, D., joint author. See under Gilman, H., Wittenberg.
18. Arajs, S. and S. Legvold. Free convectional heat transfer from a single horizontal wire. Jour. Chem. Phys. 29:697-699. 1958.
19. _____, _____. Electroconvectional heat transfer in gases. Jour. Chem. Phys. 29:531-536. 1958.
20. Armstrong, P.E., O.N. Carlson and J.F. Smith. The elastic constants of thorium single crystals in the range, 77-400°K. Jour. Appl. Phys. 30:36-41. 1959.
21. Armstrong, Ray E. Farm custom rate guide for 1959. Iowa Farm Science. 13(7): 2 pp. 1959.
Arnbal, Carl A., joint author. See under Rising.
22. Arnoff, S. and K.J. Frey. Use of radioisotopes in selected aspects of plant physiology and of radiation in plant breeding. Radiation Biological Medicine Atoms for Peace Conference, Chapter 25.
23. Arnold, L.K. and Beverly J. Schriver. Comparative solubility of protein in cottonseed flakes extracted by hexane and by ethanol. Proc. Iowa Acad. Sci. 65:230-233. 1958.
_____, joint author. See under Rao.
24. Arthur, I. W. Vocational education for non-farm jobs in southern Iowa. Agricultural Adjustment Center, I.S.C., March, 1959. 5 pp.
25. _____. Opportunities and needs for non-farm vocational education in Iowa. Agricultural Adjustment Center, I.S.C., September, 1958. 21 pp.
26. _____. Adequacy of vocational-technical training facilities for rural youth in America. National Planning Association. 1959. 15 pp.
Ashton, G.C., joint author. See under Aldinger, Heady.
27. Atkins, R.E. and J.G. Wheat. Those new barley and flax varieties. Iowa Farm Science. 13:10-12. 1959.
28. _____, _____, C.D. Hutchcroft and E.S. Dyas. Iowa grain sorghum performance tests 1954-1958. Iowa Agr. Exp. Sta. Agron. 456. January, 1959.
_____, Consulting Editor. Agronomy Journal.
_____, joint author. See under Wheat.
29. Atoji, M. On the cubic spherical harmonics. Jour. Math. and Phys. 38:73-74. 1959.
30. _____. Spherical fourier method. Acta Crystallographica. 11:827-829. 1958.
31. _____. Anhydrite obtained by the dehydration of gypsum. Jour. Chem. Phys. 30:341-342. 1959.
32. _____. The structures of calcium dicarbide and uranium dicarbide by neutron diffraction. Jour. Math. and Phys. 38:73-74. 1959.
33. _____, K. Gschneidner, Jr., A.H. Daane, R.E. Rundle and F.H. Spedding. The structures of lanthanum dicarbide and sesquicarbide by X-ray and neutron diffraction. Jour. Amer. Chem. Soc. 80:1804-1808. 1958.
34. _____ and R.E. Rundle. A neutron diffraction study of gypsum, $CaSO_4 2H_2O$. Jour. Chem. Phys. 29:1306-1311. 1958.
Aubel, C.E., joint author. See under Swenson, M.
35. Ayres, J.C. and E. L. Denisen. Maintaining freshness of berries using selected packaging materials and antifungal agents. Food Tech. 12(10): 562-567. 1958.
_____, Member of Editorial Board. Applied Microbiology.
_____, joint author. See under Fanelli, Walker.

STAFF MEMBER PUBLICATIONS, 1958-59

36. Babbitt, H.E. and E. Robert Baumann. Sewerage and sewage treatment. John Wiley and Sons. Ed. 8. 790 pp. 1958.
37. Bailey, D.M., O.N. Carlson and J.F. Smith. The aluminum-rich end of the aluminum-vanadium system. Trans. Amer. Soc. for Metals. 51: 1097-1102. 1959.
38. Baltensperger, A.A. and R.R. Kalton. Variability in reed canarygrass, Phalaris arundinacea L. I. Agronomic characteristics. Agron. Jour. 50:659-663. 1958.
39. _____, _____. Variability in reed canarygrass, Phalaris arundinacea L. II. Seed shattering. Agron. Jour. 51:37-38. 1959.
40. Bancroft, T.A. and T.A. Brindley. Methods for estimation of size of corn borer populations. Proc., 10th. Internat'l. Congr. of Entomol. 2: 1003-1014. 1958.

_____, joint author. See under McGuire.

41. Banks, C.V. Analysis of thorium. Proc., 2nd. U.N. Internat'l. Conf. on the Peaceful Uses of Atomic Energy. United Nations.
42. _____. Recent developments in the analytical chemistry of thorium and its compounds. U.S. Atomic Energy Commission TID-7555. pp. 79-144. 1958.
43. _____, C.I. Adams and J. Richard. Solubility of vic-dioximes in urea solutions. Analytica Chimica Acta. 19:531-539. 1958.
44. _____ and D.W. Barnum. Intermolecular metal-metal bonds and solubility of some nickel and palladium complexes of vic-dioximes. Jour. Amer. Chem. Soc. 80:3579-3582. 1958.
45. _____, _____. Intermolecular metal-metal bonds and absorption spectra of some nickel (II) and palladium (II) complexes of vic-dioximes. Jour. Amer. Chem. Soc. 80:4767-4772. 1958.
46. _____, K.E. Burke and J.W. O'Laughlin. The determination of fluorine in rare earth fluorides by high temperature hydrolysis. Analytica Chimica Acta. 19:239-243. 1958.
47. _____, J.P. LaPlante and J.J. Richard. Preparation of 4-carboxy-1,2-cyclohexanedionedioxime. Jour. Organic Chem. 23:1210-1211. 1958.
48. _____, J.A. Thompson and J.W. O'Laughlin. Separation and determination of small amounts of rare earths in uranium. Analyt. Chem. 30: 1792-1795. 1958.
49. _____ and R.E. Yerick. Chelating properties of N,N,N',N'-tetrakis (phosphonomethyl)-1,2-cyclohexanediamine. Analytica Chimica Acta. 20:301-314. 1959.
50. Barghusen, J., Jr. and M. Smutz. Processing of monazite sands. Indust. and Eng. Chem. 50:1754-1755. 1958.

_____, joint author. See under Knapp.

51. Barnes, Kenneth K. Progress in harvesting and handling forage. Proc., 12th Ann. Meet. Amer. Soc. of Range Management. pp. 18-21. 1959.
52. _____. Progress in harvesting and handling forage. 1959 Grassland Proc. pp. 61-63. 1959.
53. _____. Men, money and machines in farming. Proc. 72nd Ann. Conv., Iowa Bankers Assoc., 1958, Des Moines, October 19, 20, 21, 22, 1958. pp. 102-104. 1958.
54. _____, T.W. Casselman and D.A. Link. Field efficiences of 4-row and 6-row equipment. Agric. Eng. 40(3):148-150. 1959.

_____, joint author. See under Anderson, J.H., Link, McLeod.

55. Barnes, R.G. and R.D. Engardt. Unusual temperature dependence of bromine quadrupole resonances in $TiBr_4$. Jour. Chem. Phys. 29:248-249. 1958.

56. _____, _____ and R. A. Hultsch. Nuclear magnetic resonance determination of activation volume for diffusion in lithium. Phys. Rev. Letters. 2:202-204. 1959.
57. _____ and R. A. Hultsch. Indirect nuclear spin-spin interactions in pure quadrupole resonance spectra. Phys. Rev. 1:227-228. 1958.

_____, Board of Editors. Review of Scientific Instruments.

_____, joint author. See under Casabella.

Barnum, D. W., joint author. See under Banks.

58. Baroch, C. J., M. Smutz and E. H. Olson. Processing of California bastnasite ore. Mining Eng. 214:315-319. 1959.

Barron, G. L., joint author. See under Lichtwardt.

Bartholomew, W. V., joint author. See under Allos.

Bassi, B. S., joint author. See under Csanyi.

59. Bath, John A. The self-identified problems of college students. Proc. Iowa Acad. Sci. 65:405-410. 1958.

_____, joint author. See under Charles.

60. Bauder, W. W. What do Iowa farmers think of OASI? Iowa Farm Science. 13:5-7. 1959.
61. Bauer, D. C. and E. V. Morse. Variation and hemolysin production in relation to virulence of Leptospira pomona. Proc. Soc. for Exptl. Biol. and Med. 98:505-508. 1958.

Baum, E. L., joint author. See under Heady.

Baumann, E. R., joint author. See under Babbitt.

62. Beal, G. M. and E. M. Rogers. The scientist as a referent in the communication of new technology. Pub. Opinion Quart. 22:555-563. 1958.
63. Bear, Richard S. Nucleoproteins. in: The Encyclopedia of Chemistry Suppl. pp. 206-208. Reinhold Publishing Corporation, New York. 1958.

_____, Member of Editorial Board. The Journal of Biophysical and Biochemical Cytology.

64. Beaudry, B. J. and A. H. Daane. The antimony-uranium system. Trans. Metallurgical Soc. Amer. Inst. of Mining, Metallurgical and Petroleum Eng. 215:199-204. 1959.
65. Benbrook, E. A. Outline of parasites reported for domesticated animals in North America. 67 pp. Iowa State College Press. 1958.
66. Beneke, R. R. and T. R. Robinson. Agricultural adjustment and resources for vocational agriculture. The Agricultural Education Magazine 31(12): 269-272. 1959.

Bennett, P. C., joint author. See under Hofstad.

67. Benson, Patricia. Philanthropy in the U. S. A. Maral. 1:5-8. 1959. New Delhi, India.
68. Beresford, Hobart. Men, money and machines in farming. Proc. 72nd Ann. Conv., Iowa Bankers Assoc., 1958, Des Moines, October 19, 20, 21, 22, 1958. pp. 96-101. 1958.
69. Bernardes, N. and H. Primakoff. Theory of solid He^3. Phys. Rev. Letters. 2:290-292. 1959.
70. Bernstein, B. T. and J. F. Smith. Coefficients of thermal expansion for face-centered cubic and body-centered cubic calcium. Acta Crystallographica. 12:419-420. 1959.

_____, joint author. See under Smith, J. F., Wenkert.

71. Bertoni, Jose, W. E. Larson and W. D. Shrader. Determination of infiltration rates on Marshall silt loam from runoff and rainfall records. Proc. Soil Sci. Soc. Amer. 22(6):571-574. 1958.
72. Beveridge, Elizabeth and Faith M. Churchill. Household equipment experiments. Ed. 3. Iowa State College Press. 102 pp. 1958.

Biester, A., joint author. See under Leichsenring, McKinney, Swanson.

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Biester, H.E., Associate Editor. Cornell Veterinarian.

_____, joint author. See under Zimmermann.

Bird, E.W., Member of Editorial Board. Food Research.

Bishop, C.A., joint author. See under DePuy.

73. Bisque, R.E. and John Lemish. Susceptibility of some carbonate rocks to silicification. Bull. Geol. Soc. Amer. 69:1535. 1958.

74. _____, _____. Insoluble residue - magnesium content relationship of carbonate rocks from the Devonian Cedar Valley formation. Jour. Sedimentary Petrology. 29:73-76. 1959.

75. _____, _____. Chemical characteristics of some carbonate aggregates as related to durability of concrete. Highway Res. Board Bull. 196:29-45. 1958.

Black, C.A., Editor-in-chief. Methods of Soil Analysis.

_____, Associate Editor. Soil Science Society of America Proceedings.

_____, Consulting Editor. Soil Science.

_____, joint author. See under Caldwell, Moser, Peperzak, Van Diest.

76. Blackmore, D.W., L.D. McGilliard and J.L. Lush. Genetic relations between body measurements at three ages in Holsteins. Jour. Dairy Sci. 41(8):1045-1049. 1958.

77. _____, _____, _____. Relationships between body measurements, meat conformation and milk production. Jour. Dairy Sci. 41:1050-1056. 1958.

Bock, E.W., joint author. See under Burchinal.

78. Bohn, J.R. and Glenn Murphy. High-temperature fatigue testing - with application to uranium. Amer. Soc. for Testing Materials. 234:57-60. 1958.

79. Boles, Donald E. A forceful bench: the United States Supreme Court. Iowa State Scientist. 12:6-16. 1958.

80. _____. Metropolitan improvement and public housing in Iowa. Congregational Iowa. 75:16. 1959.

81. _____ and H.C. Cook. An evaluation of Iowa county government. Iowa College-Community Research Center. Ed. 1. 100 pp. 1959.

82. Bolie, Victor W. Properties of sine-x-over-x for data smoothing. Notices of the American Mathematical Soc. 6:290. 1959.

83. _____. Local blood flow and oxygen transfer rates in human skin. Stanford University (Thesis). 1959.

84. _____. An exact titration equation. Jour. Chem. Educ. 35:449-451. 1958.

85. _____. Beam phasing in a circular array of vertical antennas. Proc. Inst. Radio Eng. 47:90-92. 1959.

86. _____. Predicting absorption spectra for composite solutions. Jour. Franklin Inst. 267:143-148. 1959.

87. _____. Minimum storage matrix inversion. Zeitschrift für Angewandte Mathematik und Mechanik. 38:369-372. 1958.

88. _____. Means for digitally varying rotational velocities. U.S. Patent 2,861,475. Library of Congress. 1958.

89. _____. Tuning system for frequency synthesizing means. U.S. Patent 2,894,133. Library of Congress. 1959.

90. _____. Electrostatic meter. U.S. Patent 2,888,671. U.S. Patent Office and Library of Congress. 1959.

91. _____. Digital frequency synthesizer system. U.S. Patent 2,829,255. Library of Congress. April 1, 1958.

92. _____. Distributing delay line using non-linear parameters. U.S. Patent 2,800,596. Library of Congress. July 23, 1957.

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93. _____. Optical analogue of a radio scattering atmosphere. U.S. Patent 2,893,138. Library of Congress. 1959.
94. _____. Prediction of Iowa traffic fatalities. Proc. Iowa Acad. Sci. 65:37-38. 1958.

Boylan, D.R., joint author. See under Larson, M.A.
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Brakke, Betty E., joint author. See under Roderuck.
Bray, P.J., joint author. See under Casabella.
Brewer, Wilma, joint author. See under Leichsenring, Montoye.

95. Brindley, T.A., J.C. Chamberlin and Ralph Schopp. The pea weevil and methods for its control. U.S. Dept. of Agric. - Farmers' Bull. 1971. 24 pp. 1958.

_____, joint author. See under Bancroft, Harding, Kwolek, McGuire.
Brooks, H.G., Jr., joint author. See under Gilman, H.

96. Brown, F.E. Chemistry: the pivotal science in a liberal education. School Science and Math. 59:228-234. 1959.
97. _____. Meeting the demand for professional chemists. Jour. Chem. Educ. 35:433-435. 1958.
98. Brown, H., V.C. Speer, L.Y. Quinn, V.W. Hays and D.V. Catron. Antibody response in baby pigs challanged with Serratia marcescens. Proc. Amer. Soc. of Animal Prod. July 24, 1958., Jour. Anim. Sci. 17:1229-1230. 1958.

_____, joint author. See under Speer.
Brown, L.R., joint author. See under Jacobson, Johnson, R.H.

99. Brown, P.L. and W.D. Shrader. Grain yields, evapotranspiration and water use efficiency of grain sorghum under different cultural practices. Agron. Jour. 51:339-343. 1959.

Brown, R.G., joint author. See under Friest.

100. Browning, J. Artie. Sources of resistance to races 6 and 13A of the oat stem rust fungus. Plant Dis. Reporter. 42:948-952. 1958.

_____, joint author. See under Lilly, Wheat.

101. Bryan, Ray. A future look at vocational education. Midland School. 73: May, 1959.

Buchanan, E.B., Jr., joint author. See under Diehl.

102. Buchanan, R.E. Microbiological literacy. Bact. Rev. 22(3):204-215. 1958.
103. _____. Authorization of a committee on terminology in biological nomenclature by the International Union of Biological Sciences. Internat'l. Bull. Bact. Nomen. and Taxon. 8:191-192. 1958.
104. _____. Report of the committee on biological nomenclature. Union Internationale des Sciences Biologiques (International Union of Biological Sciences). 13:33-35. 1958.
105. _____, S.T. Cowan and W.A. Clark. Designation of neotype cultures of the type species of certain genera of the family Enterobacteriaceae: Salmonella, Shigella, Arizona, Escherichia, Citrobacter and Proteus. Internat'l. Bull. Bact. Nomen. and Taxon. 9(2):105-109. 1959.

_____, Editor. International Bulletin of Bacteriological Nomenclature and Taxonomy.
_____, Editor. General Bacteriology Section, Biological Abstracts.
_____, Editor-in-chief. Iowa State Journal of Science.

Buchholtz, W.F., joint author. See under Hampton, Knaphus, Summers.

106. Buck, Griffith J. Cold hardiness of rose varieties. Amer. Rose Ann. 44:133-137. 1959.

107. Bundy, C.E. Improving techniques of instruction. The Agricultural Education Magazine 31(5):99-104. 1958.

_____, joint author. See under Diggins.

108. Burchinal, Lee. Development of girls' sex-role identification. Jour. Home Econ. 50:708-710. 1958.

109. _____. Does early dating lead to school-age marriage? Iowa Farm Science. 13(8):11-12. 1959.

110. _____. How successful are school-age marriages? Iowa Farm Science. 13(9):7-10. 1959.

111. _____. So you want to get married. . . The Young Farmer. 5:17-20. 1959.

112. _____. Social status, measured intelligence, achievement, and personality adjustment of rural Iowa girls. Sociometry. 22:75-80. 1959.

113. _____. Some social status criteria and church membership and church attendance. The Jour. of Soc. Psych. 49:53-64. 1959.

115. _____ and E.W. Bock. Religious behavior, premarital pregnancy, and early marriage. Alpha Kappa Deltan. 29:39-44. 1959.

116. _____ and E.S. Eppright. A test of the psychogenic theory of obesity for a sample of rural girls. Amer. Jour. Clinical Nutr. 7:288-294. 1959.

_____, Abstract Editor. Marriage and Family Living.

Burke, K. E., joint author. See under Banks.

Burnet, G., joint author. See under Smutz.

117. Burns, Bernice. Eating at the Amanas. Iowan. June-July. 1959.

118. _____. Legacy of quilts. Iowan. Dec.-Jan. 1958-59.

Burrill, Lida M., joint author. See under Leichsenring, Roderuck, Swanson.

119. Burroughs, Wise, A. Raun and E. Cheng. Effects of methimazole on thyroid and live weights of cattle. Science. 128:147. 1958.

_____, joint author. See under Hubbert, Struempler.

Burrows, W.G., joint author. See under Larson, W.E., Nielsen.

120. Bush, L.J., R.S. Allen and N.L. Jacobson. Effect of chlortetracycline on nutrient utilization by dairy calves. Jour. Dairy Sci. 42:671-678. 1959.

Butcher, Walter, joint author. See under Paulsen.

121. Cabell, C.A., R.E. Davis and R.A. Saul. Relation of drying air temperature, time, and air flow rate to the nitritive value of field-shelled corn. U.S.D.A. A.R.S. Animal Husbandry Res. Div. and Agr. Engr. Res. Div. ARS 44-41. Nov., 1958.

122. Cain, C.C. and F.F. Riecken. Sequence relationships of loess-derived forested planosols in southeastern Iowa. Proc. Soil Sci. Soc. Amer. 22:445-449. 1958.

123. Caldwell, A.G. and C.A. Black. Inositol hexaphosphate: I. Quantitative determination in extracts of soils and manures. Soil Sci. Soc. Amer. Proc. 22:290-293. 1958.

124. _____, _____. Inositol hexaphosphate: II. Synthesis by microorganisms. Soil Sci. Soc. Amer. Proc. 22:293-296. 1958.

125. _____, _____. Inositol hexaphosphate: III. Content in soils. Soil Sci. Soc. Amer. Proc. 22:296-298. 1958.

_____, joint author. See under Peperzak.

Campbell, Lois J., joint author. See under Roderuck.

126. Campbell, R.B., S.C. Kelley, Jr., R.B. Talbot, and B.L. Wills. The Williston report: The impact of oil on the Williston area of North Dakota. University of North Dakota. Ed. 1. 152 pp. 1958.

Campbell, R.E., joint author. See under McKinney.
Campeti, F.J., joint author. See under Christensen, G.C.
Candler, Wilfred, joint author. See under Heady.

127. Capellen, J. and H.J. Svec. Correction of the observed ratio for errors associated with ion current collection and amplification in dual collector mass spectrometers. Iowa. State Coll. Jour. Sci. 33:427-430. 1959.

_____, joint author. See under Svec.

128. Carlander, Kenneth D. What does a fishery biologist do? Amer. Biol. Teacher. 20(6):200-203. 1958.

129. _____. Disturbance of the predator-prey balance as a management technique. Trans. Amer. Fisheries Soc. 87:34-38. 1958.

130. _____. A survey of technical fishery personnel. Trans. Amer. Fisheries Soc. 88:18-22. 1959.

_____, Associate Editor. Transactions of American Fisheries Society.
_____, Editorial Referee. Fisheries Research Board of Canada.
Carlson, O.N., joint author. See under Armstrong, Bailey.
Carlson, O.V., joint author. See under Orgell.

131. Casabella, P.A., P.J. Bray and R.G. Barnes. Electronic structure of some group III halides from pure quadrupole resonance measurements. Jour. Chem. Phys. 30:1393-1396. 1959.

Casselman, T.W., joint author. See under Barnes, K.K.

132. Catron, D.V. Give hogs what they need. The Country Guide. 77(10):12-36. 1958.

133. _____. Service is essential in feed success. Feedstuffs. 30(44):38-41. 1958.

_____, joint author. See under Aldinger, Brown, Diaz, Facto, Frape, Heady, Speer, Wilbur.
Chalaupka, Marilyn, joint author. See under Roderuck.
Chamberlin, J.C., joint author. See under Brindley.

134. Chamberlin, S.J. Spacing of spliced bars in beams. Jour. Amer. Concrete Inst. 29:689-697. 1958.

135. Chang, C.C. and C.T. Hsu. On the aerodynamic instability of supersonic inlet-diffusers. Research Report No. 115, Rosemount Aeronautical Laboratories, Univ. of Minnesota. 25 pp. 1959.

136. _____, _____. Solutions to Stoolman's external diffusion equation for instability of a normal shock inlet diffuser. AFOSR TN 58-888 and ASTIA AD 204-098. 1958.

137. Chapman, O.L. and D.J. Pasto. Photo-gamma-tropolone methyl ether. Jour. Amer. Chem. Soc. 80:6685. 1958.

138. _____, _____. 2,5-dibenzylidene-3-cyclopentenone. Jour. Organic Chem. 24:120. 1959.

_____, joint author. See under Meinwald.
Charity, L.F., joint author. See under Altman.

139. Charles, D.C. and J.A. Bath. Vocabulary and achievement in developmental psychology. Iowa Acad. Sci. Proc. 65:377-380. 1958.

140. Cheng, E. and L. Yoder. Chemical determination of isoflavones. Proc. Iowa Acad. Sci. 65:220-223. 1958.

_____, joint author. See under Burroughs, Hubbert.
Childs, Marian T., joint author. See under Roderuck.

141. Chiotti, P., H.H. Klepfer and R.W. White. Lattice parameters of uranium from 25 to 1132°C. Trans. Amer. Soc. for Metals. 51:772-786. 1959.

142. _____ and A.F. Voigt. Pyrometallurgical processing. Proc. 2nd U.N. Internat'l. Conf. on the Peaceful Uses of Atomic Energy. 17:368-375. 1958.

143. _____ and H.A. Wilhelm. Preparation of metal powders for reactors. in: Powder metallurgy in nuclear engineering by: Henry Hausner. pp. 31-50. American Society for Metals, Cleveland, Ohio. 1958.
144. Cholvin, N.R., E.V. Morse and R.F. Langham. Experimental Leptospira pomona infections in dogs. Jour. Infectious Dis. 104:92-100. 1959.

Choudhury, R.B.R., joint author. See under Reiser.

145. Christensen, G.C. and F.L. Campbell. Anatomic and functional studies of the coronary circulation in the dog and pig. Amer. Jour. Vet. Res. 20:18-26. 1959.
146. Christie, B.R. and R.R. Kalton. Sampling for seed weight determinations in bromegrass Bromus inermis Leyss. Canadian Jour. Plant Sci. 39:158-163. 1959.

Chryst, W.E., joint author. See under Miller, W.G.
Churchill, F.M., joint author. See under Beveridge.
Clark, W.A., joint author. See under Buchanan, R.E.
Coffin, W.J., joint author. See under Walker, Homer W.
Collins, C.H., joint author. See under DePuy.

147. Collins, Kenneth E. Effects of utraviolet radiation on hog cholera virus. Amer. Jour. Vet. Res. 19:540-544. 1958.
148. Collins, Robert M. Promoting adult programs with audio-visual aids. Adult Leadership. 7:72-74. 1958.

Colvin, C.B., joint author. See under Martin, Schupp.
Conover, D.F., joint author. See under Marden.
Cook, H.C., joint author. See under Boles.
Cook, J.P., joint author. See under Duke.

149. Corbett, J.D. Bismuth (I) chloride. Jour. Amer. Chem. Soc. 80:4757-4760. 1958.
150. _____. Evidence on the nature of bismuth (I) chloride formed by solution of bismuth in bismuth (III) chloride. Jour. Phys. Chem. 62:1149. 1958.
151. _____ and L.F. Druding. The gold (I) chloride-gold (III) chloride system: The nonexistence of the intermediate $Au(AuCl_4)$. Jour. Inorganic and Nuclear Chem. 11:20-23. 1959.

_____, joint author. See under McMullan.
Cowan, J.C., joint author. See under McKinney.
Cowan, S.T., joint author. See under Buchanan, R.E.
Cox, H.C., joint author. See under Harding.
Cox, L.T., joint author. See under McCarley.

152. Craft, W.A. Fifty years of progress in swine breeding. Jour. Animal Sci. 17:960-980. 1958.
153. Csanyi, L.H. Catalog of highway construction teaching aids. Amer. Road Builders' Assoc. Tech. Bull. No. 237. 47 pp. 1959.
154. _____. Foamed asphalt. Amer. Road Builders' Assoc. Tech. Bull. No. 240. 14 pp. 1959.
155. _____. Parking practices on college campuses in the United States. Iowa State College Engr. Exp. Sta. Bull. No. 181. 19 pp. 1958.
156. _____ and B.S. Bassi. Analysis of asphalts by electrical means. Proc. Assoc. of Asphalt Paving Technologists. 27:52-73. 1958.

_____, joint author. See under Nady.
Cunningham, F.M., joint author. See under Lovely.
Currence, Troy M., joint author. See under Peirce.
Curry, N.H., joint author. See under Foreman, Hazen.

Daane, A.H., joint author. See under Atoji, Beaudry, Haefling, Spedding.

Dahl, A.R., joint author. See under Hansen, J.A.

157. Dahl, J.L. and F.R. Duke. Surface tensions of binary mixtures of $PbCl_2$ and the alkali metal chlorides. Jour. Phys. Chem. 62:1498-1501. 1958.

158. _____, _____. Surface tensions of the $AgNO_3$-$NaNO_3$ and $AgNO_3$-KNO_3 systems. Jour. Phys. Chem. 62:1142-1143. 1958.

Dahm, Paul A., Member of Editorial Comm. Annual Review of Entomology, Annual Reviews, Inc.

_____, joint author. See under Lilly, Lindquist, D.A., Orgell.

Dale, R.F., joint author. See under Shaw.

159. Daniels, R.B. and R.L. Handy. Suggested new type section for the Loveland loess in western Iowa. Jour. of Geol. 67(1):114-119. 1959.

Danielson, G.C., joint author. See under Sawada, Worden.

160. Davey, Harold W. Contemporary collective bargaining. Prentice-Hall, Inc. Ed. 2. 388 pp. 1959.

160a. _____. New dimensions in collective bargaining. Harper and Bros. Ed. 1. 203 pp. 1959.

161. David, Herbert T. A three-sample Kolmogorov-Smirnov test. Ann. of Math. Stat. 29:842-851. 1958.

162. _____, E.A. Fay and J.E. Walsh. Acceptance inspection by variables when the measurements are subject to error. Ann. Inst. Stat. Math. (Japan). 10:107-129. 1959.

163. _____ and W.H. Kruskal. Correction to "the WAGR sequential t-test reaches a decision with probability one". Ann. Math. Stat. 29:936. 1958.

164. Davidson, D.T., R.K. Katti and D.E. Welch. Use of flyash with Portland Cement for stabilization of soils. Highway Res. Board, Bull. 198. pp. 1-11. 1958.

165. _____, J.B. Sheeler and N.G. Delbridge, Jr. Reactivity of four types of flyash with lime. Highway Res. Board, Bull. 193. pp. 24-31. 1958.

_____, joint author. See under Demirel, Hansen, J.A., Hoover, Nicholls, Sheeler.

Davis, Arthur W., Editor. Bulletin of the Mechanics Division of ASEE.

Davis, R.E., joint author. See under Cabell.

166. Day, B.N., L.L. Anderson, M.A. Emmerson, L.N. Hazel and R.M. Melampy. Effect of estrogen and progesterone on early embryonic mortality in ovariectomized gilts. Jour. Animal Sci. 18:607-613. 1959.

167. _____, _____, L.N. Hazel and R.M. Melampy. Pituitary gonadotrophius in swine during the estrous cycle and pregnancy. Jour. Animal Sci. 17:1233. 1958.

168. _____, _____, _____, _____. Synchronization of estrus and ovulation in swine. Jour. Animal Sci. 17:1235. 1958.

169. _____, _____, _____, _____. Gonadotrophic and lactogenic hormone potencies of gilt pituitaries during the estrous cycle and pregnancy. Jour. Animal Sci. 18:675-682. 1959.

170. Dean, G.W. and E.O. Heady. Changes in supply response and elasticity for hogs. Jour. Farm Econ. 40(4):51-62. 1958.

DeBoodt, M., joint author. See under Kirkham.

DeKalb, Edward, joint author. See under Fassel.

Delbridge, N.G., Jr., joint author. See under Davidson.

DeLeenheer, L., joint author. See under Kirkham.

STAFF MEMBER PUBLICATIONS, 1958-59

171. Delouche, James C. Germination of Kentucky bluegrass harvested at different stages of maturity. Proc. Assoc. Off. Seed Anal. 48:81-84. 1958.
172. Demirel, T., J.V. Roegiers and D.T. Davidson. Use of phosphates in soil stabilization. Proc. Iowa Acad. Sci. 65:311-316. 1958.
Denenberg, V.H., joint author. See under Karas.
Denisen, E.L., joint author. See under Ayres.
173. de Oliveira, Augusto J. Analysis of a group of experiments on oats. I. Complete data. Agronomia Lusitana. 19:329-356. 1957.
174. _____. Analysis of a group of experiments on oats. II. Incomplete data. Agronomia Lusitana. 20:155-176. 1958.
175. DePuy, C.H. and C.A. Bishop. Reactivity of tosylates in displacement and elimination reactions. Chem. and Indust. pp. 297-298. 1959.
176. _____, D.H. Froemsdorf, C.H. Collins, G.S. Hammond. The direction of elimination in the pyrolysis of acetates. Jour. Amer. Chem. Soc. 81:643-647. 1959.
177. Desai, M.V. and C.S. Reddy. Toward a uniform seed corn cold test. Phytopath. 48:386-387. 1958.
Diassi, P.A., joint author. See under Aldrich.
178. Diaz, F., V.C. Speer, P.G. Homeyer, V.W. Hays and D.V. Catron. Comparative performance of baby pigs fed infant and baby pig diets. Jour. Nutr. 68:131-140. 1959.
Dickel, D.F., joint author. See under Aldrich.
179. Didriksen, R.A. and J.H. Lilly. Granulated insecticide formulations for wireworm control. Jour. Econ. Ent. 51:463-464. 1958.
180. Diehl, H. and E.B. Buchanan, Jr. Determination of traces of iron in metallic copper. Talanta. 1:76-79. 1958.
181. _____ and F. Lindstrom. Eriochrome black T and its calcium and magnesium derivatives. Analyt. Chem. 31:414-418. 1959.
182. _____ and G. Frederick Smith. The copper reagents: cuproine, neocuproine, bathocuproine. G. Frederick Smith Chemical Co., Columbus, Ohio. Ed. 1. 48 pp. 1958.
_____, Member of Editorial Board. Talanta, International Journal of Analytical Chemistry.
_____, joint author. See under Jaselskis, Wolter.
183. Diggins, R.V. and C.E. Bundy. Sheep production. Prentice-Hall, Inc. Ed. 1. 369 pp. 1958.
184. Dillon, John L. Theoretical and empirical approaches to program selection within the feeder cattle program. Jour. Farm Econ. 40:1921-1930. 1958.
185. _____ and E.O. Heady. Decision criteria for innovation. Australian Jour. Agric. Econ. 2:113-120. 1958.
186. Doll, John P., E.O. Heady and J.T. Pesek. Fertilizer production functions for corn and oats: including an analysis of irrigated and residual response. Iowa Agric. Expt. Sta. Res. Bull. 463. pp. 363-394. 1958.
187. Dorweiler, V.P. and R.W. Fahien. Mass transfer at low flow rates in a packed column. Amer. Inst. Chem. Eng. Jour. 5:139-144. 1959.
Druding, Leonard F., joint author. See under Corbett.
188. Duke, F.R. Acid-base reactions in oxidation mechanisms. Analyt. Chem. 31:527-529. 1959.
189. _____ and J.P. Cook. A non-visual method for transport numbers in pure fused salts. II. Iowa State Coll. Jour. Sci. 33:81-83. 1958.
190. _____, _____. A moving boundary method for the determination of transport numbers in pure fused salts. Jour. Phys. Chem. 62:1593. 1958.

191. _____ and R.A. Fleming. The equivalent conductivities of $AgNO_3$-KNO_3 mixtures. Jour. Electrochem. Soc. 105:251. 1958.
192. _____, _____. Transport numbers and ionic mobilities in the system potassium chloride-lead chloride. Jour. Electrochem. Soc. 106:130-133. 1959.
193. _____ and M.L. Iverson. Kinetics of the oxidation of bromide ion in fused alkali nitrate solutions of dichromate. Analyt. Chem. 31:1233-1234. 1959.
194. _____, _____. Acid-base reactions in fused salts. I. The dichromate-nitrate reaction. Jour. Amer. Chem. Soc. 80:5061-5063. 1958.
195. _____ and B. Owens. The mobilities of the ions in fused KNO_3-$AgNO_3$ mixtures. Jour. Electrochem. Soc. 105:476-477. 1958.
196. _____, _____. Transport numbers of the pure fused salts, $LiNO_3$, $NaNO_3$, KNO_3, and $AgNO_3$. Jour. Electrochem. Soc. 105:548-549. 1958.

_____, joint author. See under Dahl.

197. Dumenil, L., J. Hanway, H.R. Meldrum and J. Pesek. Your corn may need potassium. Iowa Farm Science. 13(11):3-4. 1959.

_____, joint author. See under White, W.C.

198. Duncan, E.R. and R.H. Shaw. Crop yield outlook for 1959. Iowa Farm Science. 13(7): 2 pp. 1959.

_____, joint author. See under Engelstad.

199. Dunleavy, J.M. Studies of a seedling blight of soybeans and the etiology of the causal fungus, Diaporthe phaseolorum var. caulivora. Proc. Iowa Acad. Sci. 65:131-145. 1958.
200. Dunn, Olive Jean. Estimation of the means of dependent variables. Ann. Math. Stat. 29:1095-1111. 1958.
201. _____. Estimation of the medians for dependent variables. Ann. Math. Stat. 30:192-197. 1959.

Dwelle, Marion, Assistant Editor. Iowa Farm Science.

Dyas, E.S., joint author. See under Atkins, Wheat.

Dylion, C.M., joint author. See under Aldrich.

Easley, Eddie V., joint author. See under Ladd.

Eberts, R.E., joint author. See under Spedding.

202. Ecker, R.E. and W.R. Lockhart. A rapid membrane filter method for direct counts of microorganisms from small samples. Jour. Bact. 77:173-176. 1959.
203. _____, _____. Calibration of laboratory aeration apparatus. Appl. Microbiol. 7:102-105. 1959.

Edwards, A.P., joint author. See under Scott.

Egbert, Alvin C., joint author. See under Heady.

204. Ehrenkranz, Florence and Lydia Inman. Equipment in the home. Harper and Bros. Ed. 1. 308 pp. 1958.

Eldridge, A.C., joint author. See under McKinney.

205. Eldridge, Eber. The property tax. Farm Policy Forum. 11(2):4-11. 1958.
206. _____. The land grant college obligation. Jour. Farm Econ. 40:1879-1882. 1958.

Eldridge, J.C., joint author. See under Thomas.

207. Elford, C.R. and R.H. Shaw. Our "usual" weather. Iowa Farm Science. 13(4):5-7. 1958.
208. _____, _____. How weather forecasts are made. Iowa Farm Science. 13(3):9-11. 1958.

_____, joint author. See under Shaw.

209. Elleman, T.S., J.W. Reishus and D.S. Martin, Jr. Trichloroammine-platinate (II) ion. Hydrolysis, isotopic exchange of chloride and the trans-effect. Jour. Amer. Chem. Soc. 81:10-18. 1959.

_____, joint author. See under Martin.

Ellerhoff, M.A., joint author. See under Hendrickson.

Emmerson, M.A., joint author. See under Day, Reuber.

Engardt, R.D., joint author. See under Barnes, R.G.

210. Engelstad, O.P., W.D. Shrader and E.R. Duncan. Super cracks in your fields. Iowa Farm Science. 13:9-10. 1958.

211. Eppright, Ercel S. Teaching experiences in a college in Iraq. Jour. Amer. Dietetic Assoc. 35:449-452. 1959.

_____, joint author. See under Burchinal, Patton.

212. Erlander, S.R. A proposed mechanism for the synthesis of starch for glycogen. Enzymologiz. 19:273-283. 1958.

213. _____ and D. French. Dispersion of starch granules and the validity of light scattering results on amylopectin. Jour. Amer. Chem. Soc. 80:4413-4420. 1958.

214. _____, _____. Acid hydrolysis and molecular weights of various corn amylopectin and glycogen. Jour. Polymer Sci. 32:291-316. 1958.

215. Eslyn, Wallace. E. Radiographical determination of decay in living trees by means of the thulium x-ray unit. Forest Sci. 5:37-47. 1959.

216. Everson, L.E. Good seed costs you less. Iowa Farm Science. 13(8):18-20. 1959.

217. _____. Make sure your seed is best by test. Iowa Farm Science. 13(6): 3-6. 1958.

218. _____. A comparison of methods and blowers for the purity analysis of Kentucky bluegrass seed. Iowa State Coll. Agr. and Home Econ. Exp. Sta. Res. Bull. 464:398-407. 1958.

219. _____. Purity analysis-a historical resumé and a look at new frontiers. Golden Jubilee Publication. Assoc. Off. Seed Anal. pp. 93-95. 1958.

220. Facto, Louis A. Exposure in ultra close-ups. Photo Methods for Indust. 1(11):24-27. 1958.

221. _____. A copy camera stand made from surplus x-ray equipment. Jour. Biol. Photographic Assoc. 26(3):121-124. 1958.

222. _____, J. Kastelic and D.V. Catron. Estimating ash content of bone, using standardized radiographs. Jour. Biol. Photographic Assoc. 24(1):13-21. 1956.

Fahien, R.W., joint author. See under Dorrweiler.

Fairchild, M.L., joint author. See under Harding, Lindquist, D.A.

223. Fanelli, Mary J. and J.C. Ayres. Methods of detection and effect of freezing on the microflora of chicken pies. Food Tech. 13:294-300. 1959.

224. Fassel, V.A. and E. DeKalb. The spectrographic analysis of thorium. in: The Metal Thorium. American Society for Metals. Ed. 1. 1958.

225. _____, W.A. Gordon and R.J. Jasinski. Spectrographic determination of oxygen, nitrogen and hydrogen in metals. Proc. 2nd U.N. Internat'l. Conf. on the Peaceful Uses of Atomic Energy. United Nations.

226. _____, _____ and R.W. Tabeling. Emission spectrometric determination of oxygen in metals. in: Symposium on Spectrochemical Analysis For Trace Elements. American Society for Testing Materials. Ed. 1. 79 pp. 1958.

227. _____, _____, _____. Emission spectrometric determination of oxygen in metals. in: Determination of Gases in Metals. American Society for Testing Materials Ed. 1. 60 pp. 1958.
_____, U.S.A. Editor. Spectrochimica Acta.
_____, joint author. See under Kniseley.
Fay, Edward A., joint author. See under David.
228. Feinberg, Leonard. Fire walking in Ceylon. Atlantic Monthly. pp. 73-76. May, 1959.
229. _____ and Lilian Feinberg. Unified exercises: an English grammar and workbook. Oxford University Press. Ed. 1. 228 pp. 1959.
Feinberg, Lilian, joint author. See under Feinberg, Leonard.
230. Fischer, L.K. and J.F. Timmons. Progress and problems in the Iowa soil conservation districts program (a pilot study of the Jasper Soil Conservation District). I.S.C. Agric. Exp. Sta. Res. Bull. 466. 12 pp. Feb., 1959.
231. Fisher, R.W. and C.B. Fullhart. Feasibility studies on molten metal reactor components. Proc. 2nd U.N. Internat'l. Conf. on the Peaceful Uses of Atomic Energy. United Nations.
Fleming, R.A., joint author. See under Duke.
232. Flesch, G.D. and H.J. Svec. The mass spectra of chromyl chloride, chromyl chlorofluoride and chromyl fluoride. Jour. Amer. Chem. Soc. 81:1787-1799. 1959.
_____, joint author. See under Svec.
233. Folks, J. L. Analysis of quadruple rectangular lattice designs. Biometrics. 15:74-86. 1959.
Foos, R.A., joint author. See under Wilhelm.
234. Foreman, C.F., R.S. Allen, A.R. Porter and P.G. Homeyer. Comparison of alfalfa fed as soilage or silage and the only forage for lactating dairy cows. Jour. Dairy Sci. 41(12):1730-1737. 1958.
235. _____, N.H. Curry, P.G. Homeyer and A.R. Porter. A comparison of different types of stalls for dairy cattle. Iowa State Coll. Jour. Sci. 33:43-53. 1958.
236. Fox, Karl A. Demand expansion and agricultural adjustment. Report of Seminar on Demand for Farm Products. pp. 123-153. 1959.
237. Fox, Rodney. A landscape in transition. Landscape. 8(3):1-5. 1959.
238. Frape, D.L., R.S. Allen, V.C. Speer, V.W. Hays and D.V. Catron. Relationship of vitamin A to S^{35} metabolism in the baby pig. Jour. Nutr. 68:189-201. 1959.
239. _____, V.C. Speer, V.W. Hays and D.V. Catron. The vitamin A requirement of the young pig. Jour. Nutr. 68:173-187. 1959.
Frederick, L.R., joint author. See under McIntosh, Stickler.
240. Freeman, A.E. Curved limbs- a lethal in dairy cattle. Jour. Heredity. 49:229-232. 1958.
241. _____ and C.R. Henderson. Genetic structure of dairy cattle herds in terms of additive and dominance relationships. Jour. Dairy Sci. 42: 621-625. 1959.
242. French, D. Action mechanism of β-amylase. Proc. Internat'l Symp. on Enzyme Chem., Tokyo and Kyoto. pp. 530-532. 1957.
_____, joint author. See under Erlander, James, Thoma.
243. French, F.E., E.S. Raun and J.B. Herrick. Trolene and Dowco 109 as feed additive for grub control. Iowa State Coll. Jour. Sci. 33(2): 119-122. 1958.
Frevert, R.K., joint author. See under Johnson, H.P.
Frey, K.J., joint author. See under Abrams, Aronoff, Leininger, Lilly, Murphy, H.C., Norden, Wheat.

244. Friest, D.T. and R.G. Brown. Approximation of autocorrelation functions by a series of damped cosine functions. Proc. Natl. Elec. Conf. 14:709-714. 1958.

245. Fritschen, L.J. and W.R. Van Wijk. Use of an economical thermal transducer as a net radiometer. Bull. Amer. Meterological Soc. 40(2):291-294. 1959.

246. Fritz, J.S. and S.K. Karraker. Ion exchange separations. Chromatographic separations based on ion charge. Analyt. Chem. 31:921-923. 1959.

247. _____ and D.J. Pietrzyk. Photometric titration of scandium. Analyt. Chem. 31:1157-1159. 1959.

248. _____ and M.J. Richard. Colorimetric uranium determination with arsenazo. Analytica Chimica Acta. 20:164-171. 1959.

249. _____, _____ and S.K. Karraker. Potentiometric titrations with (Ethylenedinitrilo)-tetraacetate. Use of masking agents to improve selectivity. Analyt. Chem. 30:1347-1350. 1958.

250. _____, _____ and W.J. Lane. Spectrophotometric determination of rare earths. Analyt. Chem. 30:1776-1779. 1958.

251. _____ and G.R. Umbreit. Ion exchange separation of metal ions. Analytica Chimica Acta. 19:509-516. 1958.

252. _____, S.S. Yamamura and E.C. Bradford. Determination of carbonyl compounds. Analyt. Chem. 31:260-263. 1959.

Froemsdorf, D.H., joint author. See under DePuy.

253. Fuchs, R. and H. Gilman. Some compounds in the tri-n-hexylgermane series. Jour. Organic Chem. 23:911-913. 1958.

254. Fulcomer, David M. Becoming parents. in: American Marriage by: Ruth S. Cavan. Crowell. Ed. 1. 490 pp. 1959.

255. _____. Personal readiness for marriage. in: American Marriage by: Ruth S. Cavan. Crowell. Ed. 1. 490 pp. 1959.

Fullhort, C.B., joint author. See under Fisher.

256. Futrell, Gene A. Who gets what share of the food dollar? Iowa Farm Science. 13(12):14-16. 1959.

257. _____. How to use market news. Farmers' Digest. 22(7):69-73. 1959.

258. _____. Where to get, how to use market news. Iowa Farm Science. 13(2):7-9. 1958.

259. Gadsby, Dwight M. Iowa farm values spiral upward in 1958. Iowa Farm Science 13(8): 2 pp. 1959.

Gallup, Willis D., joint author. See under Woods.

260. Gardner, D. Bruce. Child development research. Jour. Home Econ. 51(5):354-357. 1959.

261. _____. Research on leadership in children. Jour. Nursery Educ. 13(4):19-23. 1958.

262. _____ and Damaris Pease. The use of situational test with preschool children. Jour. Nursery Educ. 14(1): 1958.

263. _____ and Marybelle K. Swiger. Developmental status of two groups of infants released for adoption. Child Development. 29:521-530. 1958.

264. Gaufin, Arden R. Production of bottom fauna in the Provo River, Utah. Iowa State Coll. Jour. Sci. 33(3):395-419. 1959.

Gay, D.G., joint author. See under Melampy.

265. George, M.V., G.D. Lichtenwalter and H. Gilman. The reactions of some metallic halides and some organomercury compounds with triphenylsilyllithium. Jour. Amer. Chem. Soc. 81:978-980. 1959.

266. _____, D. Wittenberg and H. Gilman. Reactions of azobenzene- and stilbene- dilithium adducts with some chlorosilanes. Jour. Amer. Chem. Soc. 81:361-363. 1959.

_____, joint author. See under Wittenberg.

Gerow, C.W., joint author. See under Gilman, H.

Getty, R., Chairman, AVMA Research Council. American Journal of Veterinary Research.

_____, joint author. See under Hadek.

267. Gibley, C.W., Jr. and H.L. Hamilton. Influence of certain purines and pyrimidines on the development of the down feather. The Anatomical Record. 134:568-569. 1959.

268. Gilkey, Herbert J. Some thoughts upon the why of Phi Kappa Phi. Phi Kappa Phi Jour. 39:43-46. 1959.

269. _____. Concrete. in: Civil Engineering Handbook. McGraw-Hill. Ed. 4. 100 pp. 1959.

270. Gilman, H. Morris S. Kharasch (1895-1957). Jour. Organic Chem. 23:1239-1240. 1958.

271. _____ and D. Aoki. Some reactions of RX compounds with triphenylsilyllithium in tetrahydrofuran. Jour. Organic. Chem. 24:426-427. 1959.

272. _____, _____ and D. Wittenberg. Some reactions of silyllithium compounds with epoxides. Jour. Amer. Chem. Soc. 81:1107-1110. 1959.

273. _____, H.G. Brooks, Jr. and M.B. Hughes. A qualitative test for mono-, di- and tri- substituted silanes. Jour. Organic Chem. 23:1398-1400. 1958.

274. _____ and C.W. Gerow. Metalation reactions of triphenylgermyllithium. Jour. Organic Chem. 23:1582-1584. 1958.

275. _____ and R.D. Gorsich. Cyclic organosilicon compounds. II. Reactions involving certain functional and related dibenzosilole compounds. Jour. Amer. Chem. Soc. 80:3243-3246. 1958.

276. _____ and S. Gray. Some metalation reactions in tetrahydrofuran. Jour. Organic Chem. 23:1476-1479. 1958.

277. _____, M.B. Hughes and C.W. Gerow. Cleavage studies of some organogermanium compounds. Jour. Organic Chem. 24:352-356. 1959.

278. _____ and G.D. Lichtenwalter. Addition of triphenylsilyllithium to acridine. Jour. Organic Chem. 23:1586-1587. 1958.

279. _____, H.A. McNinch and D. Wittenberg. Direct preparation of benzyllithium by cleavage reactions. Jour. Organic Chem. 23:2044-2045. 1958.

280. _____ and D. Miles. Some organosilicon compounds derived from phenyl ether. Jour. Organic Chem. 23:1363-1365. 1958.

281. _____, _____, L.O. Moore and C.W. Gerow. Some organosilicon compounds containing long-chained n-alkyl groups. Jour. Organic Chem. 24:219-224. 1959.

282. _____ and L.O. Moore. Some studies on the preparation of arylboronic acids. Jour. Amer. Chem. Soc. 80:3609-3611. 1958.

283. _____ and D.J. Peterson. Reactions of silyllithium compounds with derivatives of carboxylic acids II. Jour. Organic Chem. 23:1895-1898. 1958.

284. _____, _____ and D. Wittenberg. Direct preparation of silylmetallic compounds. Chem. and Indust. pp. 1479-1480. Nov. 8., 1958.

285. _____ and R.O. Ranck. Preparation of some N-substituted phenothiazines in tetrahydrofuran. Jour. Organic Chem. 23:1014-1018. 1958.

286. _____, _____. Some new N-substituted phenothiazine derivatives and their 5-oxide and 5, 5-dioxides. Jour. Organic Chem. 23:1903-1906. 1958.

287. _____ and T.S. Soddy. Some organolithium compounds of quinoline and 2-phenylquinoline. Jour. Organic Chem. 23:1584-1585. 1958.

288. _____ and R.A. Tomasi. An allyl displacement of a benzyl group from di- and tribenzylsilane. Jour. Amer. Chem. Soc. 81:137-139. 1959.
289. _____, E.A. Weipert and F.N. Hayes. Some derivatives of biphenyl as liquid scintillator solutes. Jour. Organic Chem. 23:910-911. 1958.
290. _____ and E.A. Zuech. A new synthesis of phenazasiline derivatives. Chem. and Indust. Sept. 20. pp. 1227-1228. 1958.
_____, Associate Editor. Organic Syntheses.
_____, joint author. See under Fuchs, George, Santucci, Wittenberg, Wu.
291. Gilman, J.C. and L.H. Tiffany. Iowa Diaportheae. Iowa Acad. Sci. Proc. 65:128-130. 1958.
292. _____, _____ and R.M. Lewis. Iowa Ascomycetes III. Diaporthaceae: Diaportheae. Iowa State Coll. Jour. Sci. 33:325-393. 1958.
293. Gless, Elmer E. and E.S. Raun. Effects of chicken body louse infestation on egg production. Jour. Econ. Ent. 52(2):358-359. 1959.
Goetsch, D.D., joint author. See under Swenson, M.
294. Good, R.H., Jr. Theory of particles with zero rest-mass. Lectures in Theoretical Physics. Interscience Publishers. 1:30-81. 1959.
_____, joint author. See under Hammer.
Gordon, W.A., joint author. See under Fassel, Kniseley.
295. Gorman, W.M. Tariffs, retaliation and the elasticity of demand for imports. Review of Econ. Studies. 25(3):133-162. 1958.
Gorsich, R.D., joint author. See under Gilman, H.
296. Gowen, J.W. Genetic consideration of leukosis tumor growth in poultry. Ann. N.Y. Acad. Sci. 71:1179-1188. 1958.
297. Grabe, Don F. Seedling characters of oats useful in trueness-to-variety tests. Proc. Assoc. Off. Seed Anal. 48:63-72. 1958.
Graca, J.G., joint author. See under White.
298. Graham, Jewel. Wise ways to can fruits and vegetables. I.S.C. Agr. and Home Econ. Expt. Sta. Bull. HE 40. 24 pp. 1959.
Gram, M.R., joint author. See under Leichsenring.
Gray, S., joint author. See under Gilman, H.
299. Green, John M. Climatic races in Guatemalan maize. Iowa State Coll. Jour. Sci. 33:111-116. 1958.
300. Green, John Morrison. Laboratory manual to accompany forumulation and analysis. Wm. C. Brown Book Co., Dubuque, Ia. Ed. 1. 24 pp. 1957.
301. _____ and M.L. Horn. Formulation and analysis in metal cutting operations. Wm. C. Brown Book Co., Dubuque, Ia. Ed. 2. 135 pp. 1957.
Griffel, M., joint author. See under Hansen, W.N., Vest.
Grindeland, Roger, joint author. See under Murphy, H.C.
Gschneidner, K., Jr., joint author. See under Atoji, Spedding.
302. Gunderson, Harold. Pest control for your lawn. Flower and Garden Magazine. 3(5):16-17. 1959.
303. _____. Controlling rats and mice in Iowa. I.S.C. Bull. P252. 4 pp. 1959.
304. _____. The best in fly control. Hoard's Dairyman. 104(13):709-715. 1959.
305. _____ and E.S. Raun. Insect and rodent prospects for 1959. Iowa Farm Science. 13(7):9-10. 1959.
306. _____ and M.C. Shurtleff. Insects and diseases in the family vegetable garden. I.S.C. Bull. P230. 8 pp. 1958.
Gurland, J., joint author. See under Lindquist, D.A., Melampy.
Guthrie, W.I., joint author. See under Hibbs.

307. Gwynne, Charles S. Geology in Mill Greek State Park. Iowa Conservationist. 18(4):128. 1959.
308. _____. Geology in Woodman Hollow State Park. Iowa Conservationist. 18(3):119-120. 1959.
309. _____. Geology in Beaver Meadow State Park. Iowa Conservationist. 18(1):99. 1959.
310. _____. Geology in Heery Woods State Park. Iowa Conservationist. 17(12):91. 1958.
311. _____. Geology in Wyth Memorial State Park. Iowa Conservationist. 17(10):76. 1958.
312. _____. Geology in Viking Lake State Park. Iowa Conservationist. 17(9):70. 1958.
313. _____. Geology in Lake MacBride State Park. Iowa Conservationist. 17(7):49-53. 1958.

314. Hadek, Robert. Histochemical studies on the uterus of the sheep. Amer. Jour. Vet. Res. 19:882-886. 1958.
315. _____. Morphological and histochemical study on the ovary of the sheep. Amer. Jour. Vet. Res. 19:873-881. 1958.
316. _____. Intraperitoneal insemination of rabbit doe. Proc. Soc. Exptl. Biol. and Med. 99:39-40. 1958.
317. _____ and R. Getty. Age-change studies of the ovary of the domesticated pig. Amer. Jour. Vet. Res. 20:578-584. 1959.
318. _____, _____. The changing morphology in the uterus of the growing pig. Amer. Jour. Vet. Res. 20:573-577. 1959.
319. Haefling, J.F. and A.H. Daane. The immiscibility limits of uranium with the rare earth metals. Trans. Metallurgical Soc. of the Amer. Inst. of Mining, Metallurgical and Petroleum Engrs. 215:336-338. 1959.
320. Hale, W.H. and R.P. King. Glucose tolerance in lambs as affected by type of ration. Proc. Iowa Acad. Sci. 65:224-229. 1958.
321. Ham, N.S. and K. Ruedenberg. Mobile bond orders in conjugated systems. Jour. Chem. Phys. 29:1215-1229. 1958.
322. _____, _____. Energy levels, atom populations, bond populations in the LCAO-MO-model and in the FE-MO-model. A quantitative analysis. Jour. Chem. Phys. 29:1199-1214. 1958.

Hamilton, E.W., joint author. See under Orgell.
Hamilton, H.L., joint author. See under Gibley.

323. Hammer, C.L. and R.H. Good, Jr. Quantization process for massless particles. Phys. Rev. 111:342-345. 1958.

_____, joint author. See under Laslett.

324. Hampton, R.O. and W.F. Buchholtz. Seasonal occurrence of Pythium graminicolum on roots of field-grown corn. Iowa State Coll. Jour. Sci. 33:489-495. 1959.

Hance, P.D., joint author. See under Aldrich.

325. Handy, R.L. Cement-soil stabilization. Highway Research Board Bull. 198. pp. 55-64. 1958.

_____, Author and editor. Screenings from the Soil Research Lab.
_____, joint author. See under Daniels, Hoover, Sheeler.

326. Hanka, L.J. and W.R. Lockhart. Determination of diethylstilbestrol in feed supplements by microbiological assay. Antibiotics and Chemotherapy. 8:584-589. 1958.

Hannum, Thomas E., joint author. See under Mills.

327. Hansen, J.A., A.R. Dahl and D.T. Davidson. Further studies of loess in Iowa: thickness, clay content, and engineering classification. Proc. Iowa Acad. Sci. 65:317-322. 1958.

328. Hansen, N.J. More dollars for your oaks? Iowa Farm Science 13(6): 4 pp. 1958.

329. Hansen, Robert S. The virial treatment of the interaction of gas molecules with solid surfaces. Jour. Phys. Chem. 63:743-745. 1959.

330. _____. Film and substrate flow in surface channels. Jour. Phys. Chem. 63:637-638. 1959.

331. _____ and T.C. Wallace. The kinetics of adsorption of organic acids at the water-air interface. Jour. Phys. Chem. 63:1085-1091. 1959.

332. Hansen, Wilford N. Some magnetic properties of the chromium (III) halides at 4.2°K. Jour. Appl. Phys. Suppl. 30:304S-305S. 1959.

333. _____ and M. Griffel. Paramagnetic susceptibilities of the chromium (III) halides. Jour. Chem. Phys. 30:913-916. 1959.

334. Hanway, J.J. and A.D. Scott. Soil potassium-moisture relations: III. Determining the increase in exchangeable soil potassium on drying soils. Soil Sci. Soc. Amer. Proc. 23:22-24. 1959.

_____, joint author. See under Dumenil, Jackson, R.D., Maasland, Nielsen, Scholtes, Scott.

335. Harding, J.A., M.L. Fairchild, T.A. Brindley, and H.C. Cox. Particle numbers of granulated carriers in relation to European corn borer control. Iowa State Coll. Jour. Sci. 33:131-138. 1958.

336. Harrenstien, H.P. and W.C. Alsmeyer. Structural behavior of a plate resembling a constant thickness bridge abutment wingwall. Iowa State College Engr. Exp. Sta. Bull. 182. 24 pp. 1959.

Harrington, William F., joint author. See under Hartman.

337. Hartley, H.O. Estimation from incomplete data in industrial research. Proc. Stat. Tech. in Missile Evaluation Symposium, at Blacksburg, Virginia. pp. 179-198. 1958.

338. _____ and L.D. Loftsgard. Linear programming with variable restraints. Iowa State Coll. Jour. Sci. 33:161-172. 1958.

339. Hartman, Paul A. The selectivity of autoclave-sterilized violet red bile agar. Food Research. 23:532-535. 1958.

340. _____. A composite sample method for the analysis of blended materials. Food Research 23:565-566. 1958.

341. _____, W.F. Harrington and M.A. Rougvie. Molecular weight of Taka-amylase B. Iowa State Coll. Jour. Sci. 33:199-200. 1958.

_____, joint author. See under Acker.

342. Haugen, Arnold O. Quail and quail feeders. Alabama Conservationist. 29(3):4-9. 1957.

343. _____. Dear hunting: Robin Hood fashion. Iowa Conservationist. 17(9): 68-69. 1958.

344. _____. Cleaning for better venison. Iowa Conservationist. 17(10):75-79. 1958.

345. _____. Breeding records of captive white-tailed deer in Alabama. Jour. Mammalogy. 40(1):108-113. 1959.

346. _____. Research for better conservation. Iowa Conservationist. 18(5): 129-131, 135-136. 1959.

347. _____ and D.W. Speake. Determining age of young fawn white-tailed deer. Jour. Wildlife Management. 22(3):319-321. 1958.

348. _____, _____. Fertilization of multiflora rose. Wildlife in North Carolina. Feb. 23(2):8. 1959.

Hayes, F.N., joint author. See under Gilman, H.

Hayes, H.W., joint author. See under Aaes-Jørgensen.
Hayles, W.J., joint author. See under Kniseley.
Hays, V.W., joint author. See under Aldinger, Brown, Diaz, Frape, Wilbur.
349. Hazel, L.N. and E.A. Kline. Ultrasonic measurement of fatness in swine. Jour. Animal Sci. 18:815-819. 1959.
_____, joint author. See under Day, Magee.
350. Hazen, T.E. and N.H. Curry. Develop new hog watering system. Iowa Farm Science. 13(6): 4 pp. 1958.
_____, joint author. See under Larson, W.E.
351. Heady, Earl O. Problems in designing dairy feeding trials for economic interpretation. in: Nutritional and Economic Aspects of Feed Utilization by Dairy Cows. by: Johnson, et al. Iowa State College Press. Ed. 1. 287 pp. 1958.
352. _____. An analysis of alternatives in control of land input to decrease grain and livestock output. Proc. Iowa State College, Agric. Adjust. Center Feed Livestock Conf. Spec. Report No. 24. pp. 149-163. 1959.
353. _____. Output in relation to input: a reply. Jour. Farm Econ. 41:405-407. 1959.
354. _____. Feasible criteria and programs for adjustment. Proc. Agric. Adjust. Center Fall Conf.: Problems and Policies of American Agriculture. Iowa State College Press. 1959.
355. _____. Allocation of resources to education under economic change in a dynamic society. Agricultural Adjustment Seminar on Education. 1959.
356. _____. The situation of agriculture. Proc. Univ. of Iowa. Urban Development Seminars. 1959.
357. _____. Models for quantitative application in watershed analysis. Proc. TVA-Farm Foundation Workshop on Watersheds. 1959.
358. _____. Farm adjustment problems: their cause and importance to sociologists. in: Rural Sociology in a Changing Economy. North Central Regional Rural Sociology Conference. pp. 2-20. 1959.
359. _____ and E.L. Baum. Some effects of selected policy programs on agricultural labor mobility. Southern Econ. Jour. 25:327-337. 1959.
360. _____ and W. Candler. Linear programming methods. Iowa State College Press. Ed. 1. 595 pp. 1959.
361. _____, D.V. Catron, D.E. McKee, G.C. Ashton and V.C. Speer. New procedures in estimating feed substitution rates and in determining economic efficiency in pork production. II. Replacement rates of corn and soybean oil in fortified rations for growing-fattening swine on pasture. Iowa State College. Res. Bull. 462. pp. 343-360. 1958.
362. _____ and A.C. Egbert. An application of programming in testing efficiency of leasing systems. Iowa State Coll. Jour. Sci. 33(2):145-160. 1958.
363. _____ and L. Ihnen. Changes in economic organization of farming to attain specified income goals. Agric. Adjust. Center Seminars: Adjustment in Southern Iowa. A case study. 1959.
364. _____and H. Jensen. Structure of farm costs. Shriftenreibe des Hauptverbandes der Landwirshaftlichen Buchstellen und Sachverstandzen. 40:102-121. 1959.
365. _____, W.G. Smith and J.A. Stritzel. What cost for liquid and dry nitrogen. Iowa Farm Science. 13(1):19-21. 1958.
366. _____ and M. Yeh. Demand functions for fertilizer. Jour. Farm Econ. 41(2):331-348. 1959.
_____, joint author. See under Dean, Dillon, Doll, Loftsgard, Paulsen, Pesek.
Hearn, W.R., joint author. See under Melampy, Rakes.

367. Heath, Harry E. Too much "tired blood" in makeup. The Quill. 46:16-18. 1958.
368. _____. The world of sports writing. Scholastic Editor. 38:5. 1958.
369. _____. College-level telecourses. Adult Leadership. 7:169-170. 1958.
_____, Editorial Advisory Board. Journalism Quarterly.
370. Heer, John F. and Carol A. Kuetemeyer. A progress report from your center for agricultural adjustment. Iowa Farm Science. 13:131-138. 1958.
_____, Assistant Publications Editor. Agricultural and Home Economics Experiment Station Cooperative Extension Service in Agriculture and Home Economics.
_____, Editor. Iowa Farm Science.
371. Held, R. Burnell and J.F. Timmons. Soil erosion control in process in western Iowa. I.S.C. Res. Bull. 460. 24 pp. 1958.
Hendershott, C.H., joint author. See under Walker, D.R.
372. Henderson, C.R., O. Kempthorne, S.R. Searle and C.M. Von Krosigk. The estimation of environmental and genetic trends from records subject to culling. Biometrics. 15:192-218. 1959.
_____, joint author. See under Freeman.
373. Hendrickson, G.O., J.M. Aikman, M.A. Ellerhoff, H.G. Hershey, F.H. Mendell, E.B. Polder, E.B. Speaker, and G.W. Worley. Report of the committee on conservation. Proc. Iowa Acad. Sci. 65:52-61. 1958.
_____, joint author. See under Johnson, Ancel M.
374. Herman, R. and C.A. Swenson. The temperature dependence of the phase transition in cerium. Jour. Chem. Phys. 29:398-400. 1958.
375. Herrick, John B. Livestock disease situation - 1959. Iowa Farm Science. 13(7): 2 pp. 1959.
376. _____. Brucellosis in cattle, hogs and peoples. I.S.C. Res. Bull. P162. 4 pp. 1959.
_____, joint author. See under French, F.E., Raun.
377. Herrnstadt, R.L. Bronson Alcott: a new view from his letters. Bull. Central Mississippi Valley Amer. Studies Assoc. 2:2-10. 1959.
Hershey, H.G., joint author. See under Hendrickson.
378. Hibbs, E.T., W.I. Guthrie and C.R. Neiswander. The yield performance of a resistant and a susceptible field corn hybrid under different intensities of European corn borer infestation. Ohio Agricultural Experiment Station Research Bull. 818. 27 pp. 1958.
_____, joint author. See under Anderson, M.A., Luckman, Orgell, Wolfenbarger.
379. Hicks, E.A. Check-list and bibliography on the occurrence of insects in birds' nests. Iowa State College Press. 681 pp. 1959.
380. _____. A new genus and species of diplogyniid from Nicaragua (Order Acarina, Family Diplogniidae). Iowa State Coll. Jour. Sci. 33:103-110. 1958.
Hilker, D.W., joint author. See under Svec.
381. Hill, J.F. and A.W. Nordskog. Heterosis in poultry. 3. Predicting combining ability of performance in the crossbred fowl. Poultry Sci. 37:1159-1169. 1958.
_____, joint author. See under Nordskog.
382. Hillyard, L.R., W.T. Hudson, W.M. Hoyt, D.M. Cook and F.L. Cason. College recruiting - a portfolio of expectations. IRE Trans. on Educ. E-2:10-13. 1959.
383. _____, L.A. Miller, D.S. Clark, Lou Russell and D.M. Cook. The journal barometer. Jour. Coll. Placement. 19:9-13, 126. 1958.

STAFF MEMBER PUBLICATIONS, 1958-59

384. Hilton, J. L. and F. G. Smith. The succinoxidase system in Myrothecium verrucaria. Iowa. State Coll. Jour. Sci. 33:279-292. 1959.
385. Hiltrop, C. L. and J. Lemish. Statistical relationship of pore-size distribution to the petrography of some carbonate rocks. Bull. Geol. Soc. Amer. 69:1583. 1958.
____, joint author. See under Lemish.
386. Hinrichsen, J. J. L. Leadership in mathematics and science. Proc. Iowa Acad. Sci. 65:68-76. 1958.
387. Hippaka, T. A. Our automated industrial revolution - Part I. Indust. Arts. and Voc. Ed. 48:1-5. 1959.
388. ____. Our automated industrial revolution - Part II. Indust. Arts. and Voc. Ed. 48:29-34. 1959.
389. ____. Our automated industrial revolution - Part III. Indust. Arts. and Voc. Ed. 48:114-118. 1959.
390. ____. Our automated industrial revolution - Part IV. Indust. Arts. and Voc. Ed. 48:139-144. 1959.
391. ____. Our automated industrial revolution - Part V. Indust. Arts. and Voc. Ed. 48:169-174. 1959.
392. Hofstad, M. S. Antigenic differences among isolates of Avian infectious bronchitic virus. Amer. Jour. Vet. Res. 19:740-743. 1958.
393. ____, E. H. McGehee and P. C. Bennett. Avian infectious hepatitis. Avian Diseases. 2:359-364. 1958.
394. Hogsett, M. L. and A. W. Nordskog. Genetic-economic value in selecting for egg production rate, body weight and egg weight. Poulty Sci. 37(6):1404-1419. 1958.
395. Holdren, B. R. The behavior of margins in wholesale and retail food distribution firms. A Report of the Seminar on Demand for Farm Products. pp. 109-122. 1959.
396. Holl, D. L., C. G. Maple and B. Vinogrado. Introduction to the laplace transform. Appleton-Century-Crafts. Ed. 1. 175 pp. 1959.
Holland, I. Irving, joint author. See under King.
397. Holland, L. A. and L. H. Hazel. Relationship of live measurements and carcass characteristics of swine. Jour. Animal Sci. 17:825-833. 1958.
398. Hollander, W. F. Laughing doves in the lab. American Biol. Teacher. 21:17-20. 1959.
399. Holloway, J. T. and L. J. Laslett. Radiations from Tb^{156}. Phys. Rev. 113:1581-1583. 1959.
Holman, R. T., joint author. See under Aaes-Jørgensen.
Homeyer, P. G., joint author. See under Diaz, Foreman, Johnson, R. H.
Hooker, A. L., joint author. See under Russell, W. A.
400. Hoover, J. M., D. T. Davidson and J. V. Roegiers. Miniature triaxial shear testing of a quaternary ammonium chloride stabilized loess. Proc. Iowa Acad. Sci. 65:323-331. 1958.
401. ____, R. L. Handy and D. T. Davidson. Durability of soil-lime-flyash mixes compacted above standard proctor density. Highway Res. Board, Bull. 193. pp. 1-11. 1958.
Horn, Milford Leon, joint author. See under Green.
402. Horton, J. C. and M. C. Shurtleff. Blights of tomato. Coop. Ext. Serv. I. S. C. P206. 1959.
403. Hougham, D. and B. M. Watts. Effect of variations in curing salts on oxidative changes in radiation sterilized pork. Food Tech. 12:681-684. 1958.
Hoyman, Wm. G., joint author. See under Wallin.

404. Hoyt, Elizabeth E. Three stages in social problems of large-scale private investment. Mankind. 3:485-490. 1959. Hyderabad, India.
405. ____. Needs beyond poverty. Maral. 1:8. 1959. New Delhi, India.
406. ____. Some thoughts on economic development among under-developed peoples. International Newsletter. 1:6. 1959.
407. ____. Security in the modern world. Board of Soc. and Econ. Relations, Methodist Church. Ed. 1. 66 pp. 1958.
408. ____. Our neighbors' families. America. C(22):656-658. 1959.
409. ____. A new approach to standards of living. Jour. Home Econ. 51:83-86. 1959.
410. ____. Caution on the western road. Maral. 1:4-5. 1959. New Delhi, India.
411. ____. Business paternalism abroad. The Christian Century. 76:292-294. 1959.
412. ____. The hour and the prayer. in: Evangelism in the 1960's. pp. 56-60. Methodist Publishers, Nashville, Tenn. Ed. 1. 104 pp. 1959.

Hsu, C.T., joint author. See under Chang.

Hubbard, E.D., joint author. See under Zimmermann.

413. Hubbert, F., Jr., E. Cheng and W. Burroughs. The influence of potassium, sodium, rubidium, lithium and cesium on in vitro cellulose digestion by rumen microorganisms with observations upon sodium and potassium influences in lamb fattening rations. Jour. Animal Sci. 17:576-585. 1958.
414. ____, ____, ____. Mineral requirement of rumen microorganisms for cellulose digestion in vitro. Jour. Animal Sci. 17:559-568. 1958.

Hubner, C.F., joint author. See under Aldrich.

Hudson, D.E., joint author. See under Savage.

415. Hughes, H.D. and J.M. Scholl. Birdsfoot trefoil. Crops and Soils. 11: 7-9. 1959.

Hughes, M.B., joint author. See under Gilman, H.

Hughes, Wm. L., Editor. Transactions, Inst. Radio Engrs. Professional Group on Broadcasting.

416. Hulsbos, C.L. Shear strength of prestressed concrete I-beams. Proc. Highway Res. Board. 37:106-117. 1958.
417. ____ and W.H. McCasland. Moment contours for bridge abutment wingwalls of constant thickness. Iowa Eng. Expt. Sta. Bull. 183. 27 pp. 1959.
418. ____ and Ti-ta Lee. Moment analysis for bridge abutment wingwalls of variable thickness. Iowa Eng. Expt. Sta. Bull. 184. 36 pp. 1959.

Hultsch, R.A., joint author. See under Barnes, R.G.

Huntress, Keith G., joint author. See under Walker, Albert L.

419. Huntsberger, David V. Elementary principles of statistics - Part I. Wm. C. Brown Book Company, Dubuque, Iowa. Preliminary Ed. 1958.

Hunziker, R.R., joint author. See under Peperzak, Scott.

Hurd, B.G., joint author. See under Kniseley.

420. Hurlburt, V.L. Distribution of income from farmland. in: Land, the Yearbook of Agriculture. 1958.

Hurley, Candace, Homemaking Editor. Iowa Farm Science.

421. Hussey, K.M. and G.A. Rosenfeld. A consideration of the problem of oriented lakes. Proc. Iowa Acad. Sci. 65:279-287. 1958.
422. Hutchcroft, Charles D. Contamination in seed fields of corn resulting from incomplete detasseling. Agron. Jour. 51:267-271. 1959.
423. ____ and J.L. Robinson. The 1958 Iowa corn yield test. I.S.C. Bull. P126. pp. 1-20. 1959.

____, joint author. See under Atkins.

Ihnen, Loren, joint author. See under Heady.
Inman, Lydia, joint author. See under Ehrenkranz.
424. Isely, Duane. Weed identification and control in the north central states. Iowa State College Press. Ed. 1. 152 pp. 1958.
425. ____. New frontiers in seed technology. Proc. Assoc. Off. Seed Anal. 48:38-41. 1958.
426. ____. A preliminary report on moisture level control in seed testing. Proc. Assoc. Off. Seed Anal. 48:125-132. 1958.
427. ____. Testing for vigor. Proc. Assoc. Off. Seed Anal. 48:136-138. 1958.
428. ____. Looking ahead - new frontiers in seed testing research and seed technology. Golden Jubilee Publ., Proc. Assoc. Off. Seed Anal. 48: 136-138. 1958.
429. ____. Leguminosae: Psoraleae of the United States. A generic summary. Iowa State Coll. Jour. Sci. 33:23-36. 1958.
Iverson, M.L., joint author. See under Duke.

430. Jackson, R.D. and D. Kirkham. Method of measurement of the real thermal diffusivity of moist soil. Soil Sci. Soc. Amer. Proc. 22:479-482. 1958.
431. Jacobson, N.L. Problems in designing feeding experiments from a nutritional standpoint. in: Nutritional and Economic Aspects of Feed Utilization by Dairy Cows. Iowa State College Press. pp. 206-212. 1959.
432. ____. Feeding and management of dairy cattle. Feeding the dairy calf. Iowa State College Pamphlet 253. January, 1959.
433. ____, L.R. Brown and L. Ratcliff. Milk replacers for veal calves. Proc. Distillers Feed Conf. 14:10-15. 1959.
____, joint author. See under Bush, Johnson, R.H., Lambert, Ratcliff.
434. James, W.J., D. French and R.E. Rundle. Studies on the Schardinger dextrins. IX. Structure of the cyclohexamylose-iodine complex. Acta Crystallographica. 12:385-389. 1959.
435. Jaselskis, B. and H. Diehl. Preparation and properties of tetraalkylammonium hexacyanocobaltates (III) and hexacyanoferrates (III). Jour. Amer. Chem. Soc. 80:4197-4198. 1958.
Jasinski, R.J., joint author. See under Fassel.
Jebe, Emil H., joint author. See under Roderuck, Swanson.
436. Jennings, L.D. and C.A. Swenson. The effects of pressure on the superconducting transition temperatures of Sn, In, Ta, Tl and Hg. Phys. Rev. 112:31-43. 1958.
437. Jensen, D. and J. Pesek. Generalization of yield equations in two or more variables. I. Theoretical considerations. Agron. Jour. 51:255-259. 1959.
438. ____, ____. Generalization of yield equations in two or more variables. II. Application to yield data. Agron. Jour. 51:259-263. 1959.
Jensen, Harald, joint author. See under Heady.
439. Johansson, I. and J.L. Lush. Zucht- und selektionsmethoden. in: Handbuch der Tierzüchtung. Vol. 2. Paul Parey, Hamburg und Berlin. Ed. 1. pp. 383-473. 1959.
440. Johnson, A.M. and G.O. Hendrickson. Effects of weather conditions on the winter activity of Mearns cottontail. Proc. Iowa Acad. Soc. 65: 554-558. 1958.
441. Johnson, H.P. and R.K. Frevert. Selected intense storms in the Little Sioux River watersheds. Jour. Amer. Soc. Agric. Engrs. 40(1):26-29. 1959.

442. Johnson, I.J. and W.H. Bragonier. Crop varieties for 1959. Iowa Farm Science. 13:11-14. 1959.
____, Associate Editor. Agronomy Journal.
____, joint author. See under Stickler.

443. Johnson, R.H., L.R. Brown, N.L. Jacobson and P.G. Homeyer. Effectiveness and practicability of some oils, penicillin, n-decyl alcohol, and lecithin in the control of alfalfa bloat. Jour. Animal Sci. 17: 893-902. 1958.

444. Johnson, R.W. and D.S. Martin, Jr. Kinetics of the oxidation of cerium (III) by concentrated nitric acid. Jour. Inorganic and Nuclear Chem. 10:94-102. 1959.
Jones, E.M., joint author. See under Montoye.
Joslin, Kenneth, joint author. See under Shepherd.

445. Junk, G. and H.J. Svec. The absolute abundance of the nitrogen isotopes in the atmosphere and compressed gas from various sources. Geochimica et Cosmochimica Acta. 14:234-243. 1958.
____, joint author. See under Svec.

446. Kaldor, Donald R. Adjusting resource organization and allocation in problems and policies of American agriculture. Iowa State College Press. Ed. 1. 1959.
____, joint author. See under Shepherd.
Kalton, R.R., joint author. See under Baltensperger, Christie, Nielson, Wassom.

447. Karas, G.G. and V.H. Denenberg. The interaction of time and duration of infantile experience upon adult learning. Proc. Indiana Acad. Sci. 68: 1959.
Karraker, S.K., joint author. See under Fritz.
Kastelic, J., joint author. See under Facto, Lowe.
Katti, R.K., joint author. See under Davidson.

448. Katz, S., J.F. Weiher and A.F. Voigt. Reaction of bis-cyclopentadienylcobalt (II) with organic halides. Jour. Amer. Chem. Soc. 80:6459. 1958.
Kelley, S.C., Jr., joint author. See under Campbell.

449. Kelton, Leonard A. and H.H. Knight. A new species of Paradacerla from Mexico, and synopsis of the genus in North America (Hemiptera, Miridae). Canadian Ent. 91:122-126. 1959.

450. Kempthorne, Oscar. Random balance: an evaluation. Technometrics. 1:159-166. 1959.

451. ____ and A.W. Nordskog. Restricted selection indices. Biometrics. 15(1):10-19. 1959.
____, Member of Editorial Board. Biometrics.
____, joint author. See under Henderson, C.R.
Kenkel, William F., Associate Editor. The Alpha Kappa Deltan.
____, joint author. See under Shafter.

452. King, D.B. and I.I. Holland. The potential demand for timber. in: Land-Yearbook of Agriculture for 1958. Govt. Printing Office. 7 pp. 1958.
King, R.P., joint author. See under Hale.

453. Kingrey, B.W. and R.L. Lundvall. Swine surgery. The Southwestern Veterinarian. 11:285-288. 1958.
____, joint author. See under Lundvall.

454. Kirkham, Don. Seepage of steady rainfall through soil into drains. Trans. Amer. Geophys. Union. 39:892-908. 1958.

STAFF MEMBER PUBLICATIONS, 1958-59

455. ____. Wasserhaushalt und Pflanzenwachstum. Oesterreichische Wasserwirtschaft. 10:223-224. 1958.

456. ____, M. DeBoodt and L. DeLeenheer. Air permeability at the field capacity as related to soil structure and yields. Mededelingen van de Landbouwhogeschool en de Opzoekingsstations van de Staat te Gent (Belgium). 24(1):337-391. 1959.

457. ____, ____, ____. Modulus of rupture determination on cylindrical soil core samples. Mededelingen van de Landbouwhogeschool en de Opzoekingsstations van de Staat te Gent (Belgium). 24(1):369-376. 1959.

458. ____, ____, ____. Modulus of rupture determination on undistrubed soil core samples. Soil Sci. 87:141-144. 1959.

459. ____, ____, ____. Physical measurements and yields on some loam and clay soils in Belgium. Mededlingen van de Landbouwhogeschool en de Opzoekingsstations van de Staat te Gent (Belgium). 24(1):324-334. 1959.

____, Consulting Editor. Soil Science.

____, joint author. See under Jackson.

Klepfer, H.H., joint author. See under Chiotti.

Kline, E.A., joint author. See under Hazel.

460. Knaphus, G. and W.F. Buchholtz. Vertical distribution of Pythium graminicolum in soil. Iowa State Coll. Jour. Sci. 33:201-207. 1958.

461. Knapp, L., R. Schoenherr, J. Barghusen and M. Smutz. A polyethylene box-type mixer-settler extractor. Indust. and Engr. Chem. 51:639-640. 1959.

462. Knight, H.H. New genera and species of North American Miridae (Hemiptera). Iowa. State Coll. Jour. Sci. 33(4):421-426. 1959.

____, Section Editor - Hemiptera. Biological Abstracts.

____, joint author. See under Kelton.

463. Kniseley, R.N., V.A. Fassel, B.B. Quinney, C. Tremmel, W.A. Gordon and W.J. Hayles. Quantitative spectrographic analysis of the rare earth elements. IX. Determination of rare earth impurities commonly associated with purified samarium, gadolinium, terbium and yttrium. Spectrochimica Acta. 12:332-337. 1958.

464. ___, ___, R.W. Tabeling, B.G. Hurd and B. B. Quinney. Quantitative spectrographic analysis of the rare earth elements. X. Determination of rare earth impurities commonly associated with purified thulium, ytterbium, lutetium, and scandium. Spectrochimica Acta. 13:300-303. 1959.

465. Koerner, E.L., M. Smutz and H.A. Wilhelm. Separation of niobium and tantalum by liquid extraction. Chem. Eng. Prog. 54(9):63-67. 1958.

466. Kolmer, Lee. Discussion: contribution of current research in food technology. Jour. Farm Econ. 40:1298-1300. 1958.

467. ____ and L.D. Loftsgaard. Vertical integration - how would it affect your farm? Iowa Farm Science. 13:3-5. 1959.

Korzun, B., joint author. See under Aldrich.

Koupal, Richard, Editor. Iowa Music Teachers Bulletin.

Kruskal, W.H., joint author. See under David.

Kuetemeyer, Carol A., Associate Editor. Iowa Farm Science.

____, Publications Assistant. Research Publications, Agric. and Home Economics Experiment Station.

____, joint author. See under Heer.

468. Kurtsveil, I. On generalized ordinary differential equations possessing discontinuous solutions. (Translation of Russian article by H.P. Thielman). Appl. Math. (Translated from Russian) 22(1):37-60. 1958.

Kutish, F.A., Editor. Farm Policy Forum.

____, joint author. See under Shepherd.

469. Kutkuhn, J.H. Utilization of gizzard shad by game fishes. Proc. Iowa Acad. Sci. 65:571-579. 1958.

470. ____. Utilization of plankton by juvenile gizzard shad in a shallow prairie lake. Trans. Amer. Fisheries Soc. 87:80-103. 1958.

471. Kwolek, W.F. and T.A. Brindley. The effects of the European corn borer, Pyrausta Nubilalis (Hbn.), on corn yield. Iowa State Coll. Jour. Sci. 33:293-323. 1959.

472. Ladd, George W. Discussion: altering marketing concepts to modern conditions. Jour. Farm Econ. 40:1523-1524. 1958.

473. ____. Book review: Marc Nerlove, the dynamics of supply: Estimation of farmers' response to price. Jour. Farm Econ. 41:452-455. 1959.

474. ____ and E.V. Easley. An application of linear programming to the study of supply response in dairying. Agric. and Home Economics Expt. Sta. Bull. RB-467. 18 pp. 1959.

475. ____ and J.R. Tedford. A generalization of the working method for estimating long-run elasticities. Jour. Farm Econ. 41:221-233. 1959.

476. Laffoon, Jean L. Proposed maintenance of Copenhagen decision 54(1)(a). Bull. Zoological Nomen. 15(23/24):762. 1958.

477. Lambert, M.R. and N.L. Jacobson. The effect of chlortetracycline feeding on cellulose digestion in the bovine rumen. Jour. Animal Sci. 17:656-661. 1958.

____, joint author. See under Ratcliff.

478. Langham, R.F., E.V. Morse and R.L. Morter. Pathology of experimental ovine Leptospirosis, Leptospira pomona infection. Jour. Infect. Dis. 103:285-290. 1958.

____, joint author. See under Cholvin, Morter.

479. Larson, M.A. and D.R. Boylan. Use of wet process by-product gypsum in fertilizer manufacture. Jour. Agric. and Food Chem. 7(6):408-410. 1959.

480. Larson, W.E., W.C. Burrows and F.E. Hazen. Equipment and methods for measurement of soil temperature. U.S.D.A. Agric. Res. Serv. Bull. ARS 41-27. pp. 1-32. 1959.

481. ____, W.G. Lovely and J.T. Pesek. Subsoiling, deep-placed fertilizer fails to raise corn yield in Iowa. Crops and Soils. p. 24. Dec., 1958.

____, Associate Editor. Soil Science Society of America Proceedings.

____, joint author. See under Bertoni.

482. Laslett, L.J. A method of applying extremal methods to problems of electrical resistance. Iowa State Coll. Jour. Sci. 33(4):431-442b. 1959.

483. ____. Computational examples illustrating the nonlinear coupling resonance $2\nu_y - \nu_x = 1$ for particle accelerators. Bull. Amer. Phys. Soc. Series II. 3(7):383. 1958.

484. ____ and C.L. Hammer. Resonant beam knock-out from an A-G synchrotron. Bull. Amer. Phys. Soc., Series II. 4(4):268. 1959.

____, joint author. See under Holloway.

485. Lassen, L.E. Tension wood in cottonwood.. Its effect on density, toughness and compression. Forest Products Jour. 9(3):116-120. 1959.

Lee, Ti-ta., joint author. See under Hulsbos.

Legvold, S., joint author. See under Anderson, G.S., Arajas, Thoburn.

486. Leichsenring, J.M., A. Biester, H. Roberts, P.P. Swanson, M.R. Gram, R.M. Leverton, W. Brewer and L.M. Burrill. Methods used for human metabolic studies in the north central region. Minn. Agric. Expt. Sta. Tech. Bull. 225, N.C. Reg. Pub. No. 80. 20 pp. 1958.

STAFF MEMBER PUBLICATIONS, 1958-59

487. Leininger, L. and K.J. Frey. Factors influencing the fluorescence of oat hulls under ultraviolet light. Agron. Jour. 50:615-618. 1958.
488. Lemish, John. The occurrence of pebble dikes in the Topia mining district, Durango, Mexico. Proc. Iowa Acad. Sci. 65:288-294. 1958.
489. ____, F.E. Rush and C.L. Hiltrop. Relationship of physical properties of some Iowa carbonate aggregates to durability of concrete. Highway Res. Board Bull. 196:1-16. 1958.
____, joint author. See under Bisque, Hiltrop.
490. Leppik, E.E. Hologeny, a complementary concept of phylogeny. Ann. Societatis Tartuensis ad Res Naturae investigandis constitutae. Series nova in exilio condita. Lund, Sweden. 1:41-51. 1957.
491. ____. Evolutionary relationship between entomophilous plants and anthophilous insects. Evolution. 11(4):466-481. 1957.
492. ____. A "literacy test" performed with anthophilous insects. Annales Societatis Litterarum Estonicae in America. 2:43-53. 1958.
____, joint author. See under Aaes-Jørgensen.
493. Leven, Charles L. A theory of regional social accounting. Papers and Proc. of the Regional Sci. Assoc. 4:231-237. 1958.
Leverton, Ruth M., joint author. See under Leichsenring, Roderuck.
Lewis, R.M., joint author. See under Gilman, J.C.
494. Lichtwardt, R.W., G.L. Barron and L.H. Tiffany. Mold flora associated with shelled corn in Iowa. Iowa State Coll. Jour. Sci. 33:1-11. 1958.
Lichtenwalter, G.D., joint author. See under George.
495. Lilly, J.H. Soil insecticides. Proc. Tenth Int. Congr. Ent. 2:151-154. 1958.
496. ____. What about aphids on sorghum? Iowa Farm Science. 13(1): 2 pp. 1958.
497. ____, L. Madamba, K.J. Frey, J.A. Browning, W.H. Orgell and P.A. Dahm. Thimet residues in small grains grown in treated soil. Jour. Econ. Ent. 51:623-625. 1958.
Lind, E.F., joint author. See under Saul.
498. Lindquist, D.A., M.L. Fairchild, P.A. Dahm and J. Gurland. Thiodan residues on corn plants. Jour. Econ. Ent. 52:102-106. 1959.
499. Lindqvist, K.J., E.V. Morse and A.M. Lundberg. Experimental Leptospira pomona infection in pregnant ewes. Cornell Vet. 45:277-290. 1958.
Lindstrom, F., joint author. See under Diehl.
500. Link, D.A. and K.K. Barnes. Is bigger machinery the answer? Iowa Farm Science. 13(8):5-7. 1959.
____, joint author. See under Barnes, K.K.
Liu, L.H., joint author. See under Aldrich, Mattson.
501. Lockhart, W.R. Use of microorganisms for studies of growth and morphogenesis. Bact. Rev. 23:8-17. 1959.
____, Assistant Editor - General Bacteriology. Biological Abstracts.
____, joint author. See under Ecker, Hanka.
502. Loftsgard, L. and E.O. Heady. An application of dynamic programming models for optimum farm and home plans. Jour. Farm Econ. 41(1): 152-165. 1959.
____, joint author. See under Hartley, Kolmer.
503. Loomis, W.E. Suspended life? Bioscope - St. John's Univ. 4:3-4. 1958.
504. ____. Photosynthesis - the basis of life. Scientia. 94: Feb., 1959.
505. ____, W.M. Struve and C.G. Waywell. Vegetation control on Iowa roadbeds. Bull. Amer. Railway Engrs. Assoc. 549:715-722. 1959.

____, Editor for Plant Physiology. Biological Abstracts.

____, joint author. See under Schiefenstein.

506. Lovely, W.G. Mechanical considerations. Proc. 15th Ann. Meet. North Central Weed Control Conf., Cincinnati, Ohio. 15:79-81. 1958.

507. ____. Applying granular herbicides for control of weeds in corn. Proc. 15th Ann. Meeting North Central Weed Control Conf. 15:11. 1958.

508. ____ and F.M. Cunningham. Characteristics of an aircraft distributor for granular materials. Agric. Res. Serv. ARS-42-25. 8 pp. 1959.

509. ____, C.R. Weber and D.W. Staniforth. Effectiveness of the rotary hoe for weed control in soybeans. Agron. Jour. 50:621-625. 1958.

____, joint author. See under Larson, Rowe, Staniforth.

Low, J.B., joint author. See under Weller.

510. Lowe, B., S. Pradhan and J. Kastelic. The free fatty acid content and the smoke point of some fats. Jour. Home Econ. 50:778-779. 1958.

511. Luckett, D.G. Professor Lutz and the structure of interest rates. Quart. Jour. Econ. 73:131-144. 1959.

512. Luckman, W.H. and E.T. Hibbs. Present status in the north central states of some Nitidulids known to damage sweet corn. Ent. Soc. Amer. North Central Branch Proc. 14: 1959.

513. Lunden, W.A. Criminal litigation in Iowa 1935-1954. Police. 3(3):48-52. 1959.

514. ____. Death by the needle. The Presidio. 26(1):29-30. 1959.

515. ____. The mobility of chiefs of police. Jour. Criminal Law, Criminology and Police Science. 49(2):178-183. 1959.

516. ____. Pioneers in criminology - Emile Durkheim, 1858-1917. Jour. Criminal Law, Criminology and Police Sci. 1959.

____, Abstractor. Excerpta Medica.

____, joint author. See under Sorokin.

517. Lundvall, R.L. Shetland pony practice. Iowa State Coll. Vet. 21:13-14. 1958-1959.

518. ____ and B.W. Kingrey. Choke in Shetland ponies, caused by boluses. Jour. Amer. Vet. Med. Assoc. 133:75-76. 1958.

____, joint author. See under Kingrey.

Lush, J.L., joint author. See under Blackmore, Johansson, Pirchner.

519. Maasland, M. and D. Kirkham. Measurement of the permeability of tri-axially anisotropic soil. Jour. of the Soil and Found. Div., Proc. Amer. Soc. Agric. Engrs. 2063:25-34. 1959.

MacPhillamy, H.B., joint author. See under Aldrich.

Madamba, L., joint author. See under Lilly.

520. Magee, W.T. and L.N. Hazel. General and specific combining ability for 154-day weight among three-line crosses in swine. Jour. Animal Sci. 18:790-795. 1959.

Mahlstede, J.P., Editor. Proceedings of the Plant Propagators Society.

____, joint author. See under Toy.

Mahoney, E., joint author. See under Montoye.

521. Malone, C.C. and L.H. Malone. Decision making and management for farm and home. Iowa State College Press. Ed. 1. 255 pp. 1958.

Malone, Lucile H., joint author. See under Malone, C.C.

Maple, C.G., joint author. See under Holl.

522. Marden, R.M. and D.F. Conover. Diagraming techniques for describing tree stems and crowns. Jour. Forestry. 57:173-175. 1959.

Marlatt, Abby I., joint author. See under Patton.

523. Martin, D.S., Jr., T.S. Elleman and J.W. Reishus. Trichloroammine-platinate (II) ion. Hydrolysis, isotopic exchange and the trans-effect. Jour. Amer. Chem. Soc. 81:10-18. 1959.

524. ____, F.D. Schupp and C.B. Colvin. Photonuclear reactions of gallium and arsenic with 70 Mev Bremsstrahlung. Phys. Rev. 113:1095-1098. 1959.

____, joint author. See under Elleman, Johnson, R.W., McCarley, Schupp.

525. Martin, N.F.G. Exceptional values of metric density. Proc. Iowa Acad. Sci. 65:335-339. 1958.

526. Marvin, K.R. Technical writing. The Iowa Publisher. 31:17-18. 1959.

527. Mattson, Roy H. and S.H. Liu. Switching V.H.F. power with semiconductor diodes. Proc. Natl. Electronics Conf. 14:325-330. 1958.

528. McCarley, R.E., D.S. Martin, Jr. and L.T. Cox. Solid state and solution exchange of platinum between $[Pt(en)Br_4]$ and $[Pt(en)Br_2]$. Jour. Inorganic and Nuclear Chem. 7:113-118. 1958.

____, joint author. See under Wilhelm.

529. McCarthy, W. Owen. Agricultural price policy in New Zealand. Jour. Farm Econ. 41:16-25. 1959.

McCasland, W.H., joint author. See under Hulsbos.

McGehee, E.H., joint author. See under Hofstad.

McGilliard, L.D., joint author. See under Blackmore.

530. McGuire, J.U., T.A. Brindley and T.A. Bancroft. Note: Errata and extension for "The distribution of the European corn borer larvae Pyrausta nubilalis (HBN.) in field corn". Biometrics. 14:432-434. 1958.

531. McIntosh, T.H. and L.R. Frederick. Distribution and nitrification of anhydrous ammonia in a Nicollet sandy clay loam. Soil Sci. Soc. Amer. Proc. 22:402-405. 1958.

McKee, D.E., joint author. See under Heady.

532. McKinley, Marjorie M. Cut costs through work simplification. School Lunch Jour. 12(9):31-33. 1958.

533. McKinney, L.L., J.C. Picken, Jr., F.B. Weakley, A.C. Eldridge, R.E. Campbell, J.C. Cowan and H.E. Biester. Possible toxic factor of trichloroethylene - extracted soybean oil meal. Jour. Amer. Chem. Soc. 81:909-915. 1959.

534. McLeod, H.E. and K.K. Barnes. Effect of paddle tip-clearance on forage blower performance. Agric. Engr. 39(8):456-457, 474. 1958.

535. McMechan, Ardis Walter. The total approach gets results. Ext. Serv. Rev. 29(8):167. 1958.

536. McMullan, R.K. and J.D. Corbett. The lower oxidation states of gallium. III. The constitution of Ga_2Cl_4 and its analogy with $Ga(AlCl_4)$. Jour. Amer. Chem. Soc. 80:4761-4764. 1958.

537. McNabb, H.S., Jr. Host-parasite interactions in woody-plant vascular diseases. Proc. Western International Forest Dis. Work Conf. 6:26-33. 1958.

538. ____. Procedures for laboratory studies on wood decay resistance. Proc. Iowa Acad. Sci. 65:150-159. 1958.

____, Editorial Board. Proceedings of the Iowa Academy of Science.

____, joint author. See under Shurtleff.

McNinch, H.A., joint author. See under Gilman, H., Wittenberg.

539. McVicker, C.D. Reading technical French. Burgess Publishing Co., Minneapolis. (Revised edition 1959) Ed. 3. 125 pp. 1959.

540. Meinwald, J. and O.L. Chapman. The rearrangement of scopinone to m-hydroxybenzaldehyde. Tetrahedron. 3:311-312. 1958.

541. Meisters, G.H. On almost periodic solutions of a class of differential equations. Proc. Amer. Math. Soc. 10(1):113-119. 1959.

542. Melampy, R.M. and D.G. Gay. A study of the weight of the corpus luteum during pregnancy in the cow. Iowa. State Coll. Jour. Sci. 33: 37-42. 1958.

543. ____, J. Gurland and J.M. Rakes. Estrogen excretion by cows after oral administration of diethylstilbestrol. Jour. Animal Sci. 18:178-186. 1959.

544. ____, W.R. Hearn and J.M. Rakes. Progesterone content of bovine reproductive organs and blood during pregnancy. Jour. Animal Sci. 18: 307-313. 1959.

545. ____ and J.M. Rakes. Induced estrus in ovariectomized cows. Iowa State Coll. Jour. Sci. 33:85-90. 1958.

____, joint author. See under Day, Rakes.

Meldrum, H.R., joint author. See under Dumenil.

546. Melhus, I.E. and J.F. Ahrens. The effect of photoperiod on the growth and development of teosinte (Euchlaena mexicana Schrad.). Ceiba. 8: 1-16. 1959.

Mendell, F.H., joint author. See under Hendrickson.

Metzler, David E., joint author. See under Yatco-Manzo, Yount.

Mickel, L.J., joint author. See under Simons.

547. Mickey, Ray. Some bounds on the distribution functions of the largest and smallest roots of normal determinantal equations. Ann. Math. Stat. 30:242-243. 1959.

Miles, D.H., joint author. See under Gilman, H., Wittenberg.

548. Miller, Walter G., W.E. Chryst and H.W. Ottoson. Relative efficiencies of farm tenure classes in intrafirm resource allocation. Iowa State Coll. Res. Bull. 461. 24 pp. 1958.

Mills, B., joint author. See under Walker, Albert L.

549. Mills, D.H. and T.E. Hannum. The transparency of the Taylor scale of manifest anxiety in a college population. Jour. Appl. Psychology. 43:8-11. 1959.

550. Montoye, H.J., W.D. Van Huss, W.D. Brewer, E.M. Jones, M.A. Ohlson, E. Mahoney and H. Olson. The effects of exercise on blood cholesterol in middle-aged men. Amer. Jour. Clin. Nutr. 7:139-145. 1959.

Moore, L.O., joint author. See under Gilman, H.

551. Morgan, Paul E. Certification program for sewage treatment plant operators. League of Iowa Municipalities. 14(2):20-24. 1959.

552. Morse, E.V. What you should know about Leptospirosis. Iowa State Coll. Vet. 21:63-65. 1959.

553. ____. Current Leptospirosis dianostic problems. Proc. U.S. Livestock Sanitary Assoc. 1958 Meet. 1958.

____, joint author. See under Bauer, Langham, Lindquist, K.J., Morter.

554. Morter, R.L., R.F. Langham and E.V. Morse. Experimental Leptospirosis. VI. Histopathology of the bovine placenta in Leptospira pomona infections. Amer. Jour. Vet. Res. 19:785-791. 1958.

555. Moser, U.S., W.H. Sutherland and C.A. Black. Evaluation of laboratory indexes of absorption of soil phosphorus by plants. Plant and Soil. 10:356-374. 1959.

556. Munson, R.D. and J.T. Pesek. The effects of corn residue nitrogen and incubation on nitrogen release and subsequent nitrogen uptake by oats: a quantitative evoluction. Soil Sci. Soc. Amer. Proc. 22:543-547. 1958.

557. Murphy, Glenn. New demands on engineering education. I.R.E. Trans. on Educ. E-1:116-119. 1958.

____, joint author. See under Bohn.

558. Murphy, H.C., F. Petr and K.J. Frey. Lodging resistance studies in oats. I. Comparing methods of testing and sources of straw strength. Agron. Jour. 50:609-611. 1958.
559. ____, F.J. Zillinsky, M.D. Simons and R. Grindelind. Inheritance of seed color and resistance to races of stem and crown rust in Avena strigosa. Agron. Jour. 50:539-541. 1958.
____, joint author. See under Simons, Zillinsky.

560. Nady, R.M. and L.H. Csanyi. Use of foamed asphalt in soil stabilization. Proc. Highway Res. Board. 37:452-467. 1958.
Nakamaya, H., joint author. See under Van Zante.
Naumann, A.W., joint author. See under Spedding.
561. Nelson, F.E. Is your problem with antibiotics or with phage? Milk Indust. Found, Conv. Proc., Lab. Section. pp. 21-27. 1958.
562. Newman, J.E., R.H. Shaw and V.E. Suomi. The agricultural weather station. Its instruments, observations and site requirements. North Central Reg. Pub. No. 97, Bull. 537 Agric. Exp. Sta. Madison, Wisc. June, 1959.
563. Nicholls, R.L. and D.T. Davidson. Polyacids and lignin used with large organic cations for soil stabilization. Highway Res. Board Proc. 37: 517-537. 1958.
564. Nielsen, D.R., D. Kirkman and W.C. Burrows. Solids-water-air space relations of some Iowa soils. Iowa State Coll. Jour. Sci. 33:111-116. 1958.
565. ____, ____ and R.E. Phillips. Synthetic soil conditioners. Iowa Farm Science. 13(8):8-10. 1959.
566. ____ and R.E. Phillips. Small fritted glass bead plates for determination of moisture retention. Soil Sci. Soc. Amer. Proc. 22:574-575. 1958.
567. ____ and R.H. Shaw. Estimation of the 15 stmosphere moisture percentage from hydrometer data. Soil Sci. 86:103-105. 1958.
____, joint author. See under Shaw.
568. Nielson, A.K. and R.R. Kalton. Combining ability for seed characteristics in Bromus inermis Leyss. Agron. Jour. 51:178-181. 1959.
Neiswander, C.R., joint author. See under Hibbs.
569. Norden, A.J. and K.J. Frey. Effect of lodging on yield and test weight of oats and establishment of alfalfa seedlings. Proc. Iowa Acad. Sci. 65:190-196. 1958.
570. Nordskog, A.W. and J.F. Hill. Correlation between egg production and adult viability in hybrid flocks. Pountry Sci. 37(6):1265-1273. 1958.
____, joint author. See under Hill, Hogsett, Kempthorne.
571. Norton, R.A. Progress in pole construction. Iowa Farm Science. 13: 63-66. 1958.

572. O'Byrne, J.C. and J.F. Timmons. Planning farm property transfers within families in Iowa. Iowa State College Res. Bull. P125. 44 pp. 1959.
Ogren, J.R., joint author. See under Smith, J.F.
Ohlson, M.A., joint author. See under Montoye, Swanson.
O'Laughlin, J.W., joint author. See under Banks.
Olson, E., joint author. See under Smutz.
Olson, E.H., joint author. See under Baroch.
Olson, H., joint author. See under Montoye.

574. Orgell, W.H., K.A. Vaidya and P.A. Dahm. Cholinesterase inhibition in vitro by extracts of potato. Proc. Iowa Acad. Sci. 65:160-162. 1958.

575. ____, ____, ____. Inhibition of human plasma cholinesterase in vitro by extracts of solanaceous plants. Science. 128:1136-1137. 1958.

576. ____, ____, E.W. Hamilton and P.A. Dahm. Endogenous cholinesterase-inhibitory substances in the plant family Solanaceae. Bull. Ent. Soc. Amer. 4:84. 1958.

____, joint author. See under Lilly.

Orlovich, Robert B., joint author. See under Walker, Albert L.

577. Orr, Robert W. Iowa State College centennial. Final report. Iowa State College Library. 38 pp. 1958.

Ottoson, H.W., joint author. See under Miller, W.G.

578. Owen, John B. The erosion-littoral zone of North Twin Lake and its relation to dredging. Iowa State Coll. Jour. Sci. 33:91-102. 1958.

Owens, B., joint author. See under Duke.

579. Paloumpis, A.A. The effects of drought conditions on the fish and bottom organisms of two small oxbow ponds. Trans. Ill. State Acad. Sci. 50(1957):60-64. 1958.

580. ____. Measurement of some factors affecting the catch in a minnow seine. Proc. Iowa Acad. Sci. 65:580-586. 1958.

Pasto, D.J., joint author. See under Chapman.

581. Patton, Mary B., Charlotte Roderuck, Ercel S. Eppright and Abby I. Marlatt. Nutritional status of 9-, 10-, and 11-year-old public school children in Iowa, Kansas and Ohio. II. Blood findings. Ohio Agric. Exper. Station Res. Bull. 794, NC Reg. Pub. 72. 63 pp. 1957.

582. Paulsen, Arnold. Supply response to grain land rental rates. Jour. Farm Econ. 40(5):1839-1845. 1958.

583. ____, E.O. Heady and W. Butcher. A look at the conservation reserve. Iowa Farm Science. 13(12):7-11. 1959.

584. Payton, C.E. and L.A. Thomas. The petrology of some Pennsylvanian black "Shales". Jour. Sedimentary Petrology. 29:34-40. 1959.

585. Pearson, P.T. A five-year survey of canine Nephritis. Iowa State Coll. Vet. 21:125-129. 1959.

586. Pease, Damaris. A report to parents - about children's social development. Iowa Farm Science. 13(10): 1959.

587. ____. A report to parents - modern day views. Iowa Farm Science. 13(10):6-8. 1959.

588. ____. Research, a way of life. Jour. Nursery Educ. 14(2):18-20. 1959.

589. ____. Child development laboratory notebook. Wm. C. Brown Co., Dubuque, Iowa. 1958.

____, joint author. See under Gardner.

590. Pederson, V.A. A new method of obtaining systemic infection of soybeans by Peronospora manshurica (Naoum.) Syd. Proc. Iowa Acad. Sci. 65:146-149. 1958.

591. Peet, Louise J. Young homemakers equipment guide. Iowa State Coll. Press. 244 pp. 1958.

592. Peirce, L.C. and T.M. Currence. The efficiency of selecting for earliness, yield, and fruit size in a tomato cross. Amer. Soc. Hort. Sci. 73:294-304. 1959.

Pemberton, J.R., joint author. See under Acker.

593. Peperzak, P., A.G. Caldwell, R.R. Hunziker and C.A. Black. Phosphorus fractions in manures. Soil Sci. 87:293-302. 1959.

594. Pesek, John and E.O. Heady. Derivation and application of a method for determining minimum recommended rates of application of fertilizer. Proc. Soil Sci. Soc. Amer. 22(5):419-423. 1958.

____, joint author. See under Doll, Dumenil, Jensen, Larson, I.J., Munson, Webb, White, W.C.

Peterson, D.J., joint author. See under Gilman, H.

595. Peterson, D.T. and D.G. Westlake. Solubility of thorium dihydride in thorium metal. Trans. Metallurgical Soc. of AIME. 215:444-447. 1959.

596. Peterson, Peter A. The effect of temperature on the mutation rate of a mutable locus in maize. Jour. Heredity. 49(3):120-124. 1958.

Petr, F., joint author. See under Murphy, H.C.

597. Phillips, Richard. Your sales program -- how does it stack up? Hatchery and Feed. 32(11):10-12. 1958.

598. ____. Pricing and discounts -- how they affect hatchery and feed store sales and profits. Hatchery and Feed. 32(9):38-40. 1958.

599. ____. Sagging profit lines can be cured. Farm Store Merchandising. 1(4):32-33. 1958.

600. ____. Charge the right price -- it's most profitable. Farm Store Merchandising. 1(5):26-27. 1958.

601. ____. The dealers margins -- what should they be? Farm Store Merchandising. 1(6):30-31. 1958.

602. ____. Farm store owners may be able to save on income taxes. Farm Store Merchandising. 2(1):12-14. 1959.

603. ____. Is an outside serviceman profitable for the farm store? Farm Store Merchandising. 2(2):26-27. 1959.

604. ____. Is your employees' work schedule making you money? Farm Store Merchandising. 2(3):26-27. 1959.

605. ____. Follow these 3 steps for selecting good employees. Farm Store Merchandising. 2(4):36-40. 1959.

606. ____. Professional development of farm store employees. Farm Store Merchandising. 2(5):26-27. 1959.

607. ____. Profitable pay and benefit programs for farm store employees. Farm Store Merchandising. 2(6):10-11. 1959.

608. ____. Here's how to pick the lines that are profitable. Farm Store Merchandising. 1(3):50-51. 1958.

____, joint author. See under Nielsen.

Picken, J.C., Jr., joint author. See under McKinney.

Pietrzyk, D.J., joint author. See under Fritz.

609. Pirchner, F. and J.L. Lush. Genetic and environmental portions of the variation among herds in butterfat production. Jour. Dairy Sci. 42:115-122. 1959.

Polder, E.B., joint author. See under Hendrickson.

Porter, A.R., joint author. See under Foreman.

610. Powell, J.E. and M.A. Hiller. A method of adjusting pH without introducing extraneous cations or anions. Jour. Inorganic and Nuclear Chem. 9:100. 1959.

611. ____ and F.H. Spedding. Basic principles involved in the macroseparation of adjacent rare earths from each other by means of ion exchange. Chem. Engr. Prog. Symposium Series. 55(24):101-113. 1959.

612. ____, ____. The separation of rare earths by ion exchange. Trans. Metallurgical Soc. of AIME. 215:457-463. 1959.

____, joint author. See under Spedding.

Pradhan, Sarala, joint author. See under Lowe.

Primakoff, H., joint author. See under Bernardes.

Quinn, L.Y., joint author. See under Acker, Brown, H., Speer, Wilbur.
Quinney, B.B., joint author. See under Kniseley.

613. Rakes, J.M., W.R. Hearn and R.M. Melampy. A method for the determination of progesterone in tissues and body fluid. Iowa State Coll. Jour. Sci. 33:13-22. 1958.
____, joint author. See under Melampy.
Ranck, R.D., joint author. See under Gilman, H.
614. Rao, R.K. and L.K. Arnold. Alcoholic extraction of vegetable oils. Iowa Eng. Expt. Station Report 30. 28 pp. 1958.
615. Ratcliff, L., N.L. Jacobson, and R.S. Allen. Effect of age and of dietary regime on hemoglobin and reducing sugar levels in the blood of dairy calves. Jour. Dairy Sci. 41:1401-1406. 1958.
616. ____, M.R. Lambert and N.L. Jacobson. What roughage for dairy calves? Iowa Farm Science. 13(3):3-4. 1958.
____, joint author. See under Jacobson.
Raun, A., joint author. See under Burroughs, French, F.E., Gless, Gunderson.
617. Raun, E.S. and J.B. Herrick. Systemic insecticides control cattle grubs. Iowa Farm Science. 13(2):3-4. 1958.
618. Razumikin, B.S. Stability in first approximation of systems with lag. (Translated from Russian by H.P. Thielman). Jour. Appl. Math. and Mechanics. (Translated from the Russian) 22(2):215-229. 1958.
Read, A.A., joint author. See under Svec.
Reddy, C.S., joint author. See under Desai.
Reed, M.G., joint author. See under Scott.
619. Reiser, R. and R.B.R. Choudhury. On the origin of stearic acid in ruminant depot fat. Jour. Amer. Oil Chem. Soc. 36:129-130. 1959.
Reishus, J.W., joint author. See under Elleman, Martin.
620. Reuber, H.W. and M.A. Emmerson. Arteriography of the internal genitalia of the cow. Jour. Amer. Vet. Med. Assoc. 134:101-109. 1959.
Richard, J., joint author. See under Banks.
Richard, M.J., joint author. See under Fritz.
621. Richards, Allen B. Some economic considerations of the multiple use of forest land. Land Econ. 34:263-268. 1958.
____, joint author. See under Shepherd.
622. Richter, W.R. Observations on the penile development of the angora goat. Amer. Jour. Vet. Res. 20:603-606. 1959.
623. ____. Adienal cortical adenomata in the goat. Amer. Jour. Vet. Res. 73:895-901. 1958.
Riecken, F.F., joint author. See under Cain.
624. Rising, James S. Course content in basic engineering graphics. Jour. Eng. Graphics. 22(3):32-34. 1958.
625. ____ and M.W. Almfeldt. Engineering graphics. Wm.C. Brown Pub. Co., Dubuque, Iowa. Ed. 2. 432 pp. 1959.
626. ____ and C.A. Arnbal. Engineering graphics, problem book I. Wm. C. Bown Pub. Co., Dubuque, Iowa. Ed. 1. 65 pp. 1959.
Robb, E.W., joint author. See under Aldrich.
Roberts, H., joint author. See under Leichsenring.
Robinson, J.L., joint author. See under Hutchcroft.
Robinson, T.R., joint author. See under Beneke.
627. Robotka, Frank. Cooperative progress in world perspective. Amer. Coop., 1958 - Proc. Ann. Sess. Amer. Inst. Coop., Washington, D.C. pp. 412-423. 1958.

Roddy, Frances, joint author. See under Yatco-Manzo.

628. Roderuck, C., L. Burrill, L.J. Campbell, B. Einbecker Brakke, M.T. Childs, R. Leverton, M. Chaloupka, E.H. Jebe and P.P. Swanson. Estimated dietary intake, urinary excretion and blood vitamin C in women of different ages. Jour. Nutr. 66:15-27. 1958.

____, joint author. See under Patton.

Roegiers, J.V., joint author. See under Demirel, Hoover.

Rogers, E.M., joint author. See under Beal.

Rosenfeld, G.A., joint author. See under Hussey.

Rothacher, R.R., joint author. See under Tarr.

629. Rothenbuhler, Walter C. Progress and problems in the analyses of gynandromorphic honey bees. Proc. 10th Internat'l. Congress Ent. 2:867-874. 1958.

____, Consulting Editor. American Bee Journal.

Rougvil, M.A., joint author. See under Hartman.

630. Rowe, R.J. and W.G. Lovely. A Lister planter attachment for side-band placement of starter fertilizer. U.S.D.A. Agric. Res. Serv. ARS-42-26. 6 pp. 1959.

631. Roy, S.J. and J.P. Mahlstede. Responses of rose plants to cane coating with melted paraffin wax. Iowa State Coll. Jour. Sci. 33:475-488. 1959.

Roychaudhuri, D.K., joint author. See under Aldrich.

632. Ruedenberg, K. A theorem on the mobile bond orders of alternant conjugated systems. Jour. Chem. Phys. 29:1232-1233. 1958.

____, joint author. See under Ham.

633. Ruhe, R.V. Stone lines in soils. Soil Sci. 87:223-231. 1959.

Rundle, R.E., joint author. See under Amma, Atoji, James, Smith, H., Williams.

Runkles, J.R., joint author. See under Shaw.

Rush, F.E., joint author. See under Lemish.

634. Russell, Glen A. The reactions of resonance stabilized anions. I. Neutralization of the α,α'-dimethylbenzyl carbanion. Jour. Amer. Chem. Soc. 81:2017-2022. 1959.

635. ____. Fundamental processes of autoxidation. Jour. Chem. Educ. 36: 111-118. 1959.

636. ____. Nature of the polar effect in reactions of atoms and free radicals. Jour. Organic Chem. 23:1407-1409. 1958.

637. ____. Electron transference in the attack of atoms or radicals upon carbon-hydrogen bonds. Tetrahedron. 5:101-102. 1959.

638. ____. Solvent effects in the reactions of free radicals and atoms. V. Effects of solvents on the reactivity of t-butoxy radicals. Jour. Organic Chem. 24:300-302. 1959.

639. ____. Solvent effects in the reactions of free radicals and atoms. IV. Effects of aromatic solvents in sulfuryl chloride chlorinations. Jour. Amer. Chem. Soc. 80:5002-5003. 1958.

640. ____. Solvent effects in the reactions of free radicals and atoms. II. Effects of solvents on the position of attack of chlorine atoms upon 2,3-dimethylbutane, isobutane and 2-deuterio-2,-methylpropane. Jour. Amer. Chem. Soc. 80:4987-4996. 1958.

641. ____. Solvent effects in the reactions of free radicals and atoms. III. Effects of solvents in the competitive photochlorinations of hydrocarbons and their derivatives. Jour. Amer. Chem. Soc. 80:4997-5001. 1958.

642. Russell, W.A. and A.L. Hooker. Inheritance of resistance in corn to rust, Puccinia sorghi Schw., and genetic relationships among different sources of resistance. Agron. Jour. 51:21-24. 1959.

Sadanaga, K., joint author. See under Simons, Zillinsky.

643. Sandoval, A. and R.H. Shaw. Relation of solar radiation measurements at Ames to sunshine observations at Des Moines. Iowa State Coll. Jour. Sci. 33:173-184. 1958.

644. Santucci, L. and H. Gilman. Metalation of phenolic and phenol ether systems. Jour. Amer. Chem. Soc. 80:4537-4539. 1958.

645. Saul, R.A. and E.F. Lind. Maximum time for safe drying of grain with unheated air. Trans. of the ASAE. 1(1):29-33. 1958.

____, joint author. See under Cabell.

646. Savage, W.R., D.E. Hudson and F.H. Spedding. A mass spectrometric study of heats of sublimation of dysprosium, samarium, thulium and ytterbium. Jour. Chem. Phys. 30:221-227. 1959.

647. Sawada, S. and G.C. Danielson. Domain structure of WO_3 single crystals. Phys. Rev. 113:1005-1008. 1959.

648. ____, ____. Electrical conduction in crystals and ceramics of WO_3. Phys. Rev. 113:803-805. 1959.

649. ____, ____. Optical indices of refraction of WO_3. Phys. Rev. 113:1008-1013. 1959.

650. Schapaugh, William. Salsala collina Pall., new to Iowa. Proc. Iowa Acad. Sci. 65:118-121. 1958.

651. Schieferstein, R.H. and W.E. Loomis. Growth and differentiation of the epidermal wall. Proc. Iowa Acad. Sci. 65:163-165. 1958.

652. Schirber, J.E. and C.A. Swenson. The superconductivity of β mercury. Phys. Rev. Letters. 2:296-297. 1959.

Schlittler, E., joint author. See under Aldrich.

653. Schmulbach, J.C. Angling success on the Des Moines. Iowa Conservationist. 17(8):57, 63-64. 1958.

Schoenhern, R., joint author. See under Knapp.

654. Scholl, J.M. and C.P. Wilsie. Using alfalfa for rotation pasture. Iowa Farm Science. 13:3-6. 1959.

____, joint author. See under Hughes.

655. Scholtes, W.H. and D. Kirkham. The use of radiocarbon for dating soil strata. Pedologie (Belgium). 7:316-323. 1957.

Schopp, R., joint author. See under Brindley.

656. Schupp, F.D., C.B. Colvin and D.S. Martin, Jr. Photonuclear reactions of gallium and arsenic with 70-Mev Bremsstrahlung. Phys. Rev. 113:1095-1098. 1959.

____, joint author. See under Martin.

Schwarte, L.H., joint author. See under Zimmermann.

657. Scott, A.D., J.J. Hanway and A.P. Edwards. Replaceability of ammonium in vermiculite with acid solutions. Soil Sci. Soc. Amer. Proc. 22:388-392. 1958.

658. ____, H.H. Hunziker and M.G. Reed. Solubility of potassium tetraphenylboron in acetone-water solutions. Chemist-Analyst. 48:11-12. 1959.

____, joint author. See under Hanway.

Searle, S., joint author. See under Henderson, C.R.

659. Seifert, George. The asymptotic behavior of solutions of pendulum-type equations. Ann. Math. 69:75-87. 1959.

660. ____. Rotated vector fields and an equation for relaxation oscillations. Contributions to the Theory of Nonlinear Oscillations IV, Ann. Math. Study No. 41. pp. 125-139. 1958.

STAFF MEMBER PUBLICATIONS, 1958-59

661. Sell, Jerry. Incidence of persistent right oviducts in the chicken. Poultry Sci. 38:33-35. 1959.
662. Shafter, A.J. and W.F. Kenkel. The predictive value of the concept familism. The Alpha Kappa Deltan. 29:36-38. 1959.
663. Shaw, R.H. When will it snow in the fall. Iowa Farm Science. 13(5): 7-8. 1958.
664. ____. Water use from plastic covered and uncovered corn plots. Agron. Jour. 51:172-173. 1959.
665. ____ and R.F. Dale. Climate and corn yields in Iowa. Weekly Weather and Crop Bull. 56(19):7-8. 1959.
666. ____ and C.R. Elford. Iowa weather patterns. Iowa Farm Science. 13(2):11-14. 1958.
667. ____, D.R. Nielsen and J.R. Runkles. Evaluation of some soil moisture characteristics of Iowa soils. Iowa State Coll. Res. Bull. 465:410-420. 1959.
____, joint author. See under Duncan, Elford, Newman, Sandoval.
668. Sheeler, J.B., D.T. Davidson and R.L. Handy. Effects of a synthetic resin on differential thermal analysis of loess. Clays and Clay Minerals, 5th Natl. Conf. on Clays and Clay Minerals, NAS-NRC Publ. 566. pp. 189-196. 1958.
____, joint author. See under Davidson.
669. Shepherd, Geoffrey. How much too large are the stock of feed grains? Feed-Livestock Workshop Proc., Iowa State College. pp. 53-70. 1959.
670. ____. Is corn production leaving the corn belt? Iowa Farm Science. 13(3):12-14. 1958.
671. ____. Corn -- is production leaving the corn belt? Co-op Grain Quart. Winter Issue. 3 pp. 1958-59.
672. ____. Marketing farm products. Iowa State College Press. Ed. 3. 497 pp. 1958.
673. ____. A new gimmick for an old crop. Co-op Grain Quart. Fall Issue. 3 pp. 1958.
674. ____ and K. Joslin. A different base for corn price supports? Iowa Farm Science. 13(4):3-4. 1958.
675. ____ and A. Richards. Effects of the federal programs for corn and other grains on corn prices, feed grains production and livestock production. North Central Reg. Publ. No. 89. 27 pp. 1958.
676. ____, ____. Does the loan and storage program support corn prices? Iowa Farm Science. 13(5): 2 pp. 1958.
677. Shimanov, S.N. Finding the characteristic exponents of systems of linear differential equations with periodic coefficients. (Translation from the Russian by H.P. Thielman). Jour. Appl. Math. and Mech. (Translated from the Russian). 22(3):526-531. 1958.
Shrader, W.D., joint author. See under Bertoni, Brown, P.L., Engelstad, Stickler.
678. Shurtleff, M.C. Plant disease prospects for 1959. Iowa Farm Science. 13(7): 2 pp. 1959.
679. ____ and H.S. McNabb, Jr. Cedar-apple and related rusts of trees and shrubs. Coop. Ext. Serv., Iowa State Coll. Pamphlet 254. 1959.
680. ____, ____. Antracnose or leaf scorch of shade trees. Coop. Ext. Serv. Iowa State Coll. Pamphlet 256. 4 pp. 1959.
681. ____, ____. Fire blight of fruits and ornamentals. Coop. Ext. Serv., Iowa State Coll. Pamphlet 255. 4 pp. 1959.
____, joint author. See under Gunderson, Horton.

682. Simons, M.D. and L.J. Michel. Physiologic races of crown rust of oats identified in 1957. Plant Dis. Reporter. 42:1246-1249. 1958.

683. ____, ____. A comparison of different methods used in conducting surveys of races of the crown rust fungus. Plant Dis. Reporter. 43:464-469. 1959.

684. ____, K. Sadanaga, and H.C. Murphy. Inheritance of resistance of strains of diploid and tetraploid species of oats to races of the crown rust fungus. Phytopath. 49:257-259. 1959.

____, Editor. Phytopathology.

____, joint author. See under Murphy, H.C., Zillinsky.

Smith, F.G., Associate Editor. Biological Abstracts - Plant Physiology Section.

____, joint author. See under Hilton.

Smith, G.F., joint author. See under Diehl.

685. Smith, G.W. Applying the techniques of engineering economy to life insurance decisions. The Engineering Economist. 4(4):43-49. 1959.

686. Smith, H.G. and R.E. Rundle. The silver perchlorate-benzene complex, $C_6H_6 \cdot AgClO_4$, crystal structure and charge transfer energy. Jour. Amer. Chem. Soc. 80:5075-5080. 1958.

687. Smith, J.F. Physical constants, crystal, and thermodynamic properties. in: The Metal Thorium. American Society for Metals, Cleveland, Ohio. Ed. 1. 397 pp. 1958.

688. ____ and B.T. Bernstein. Effects of impurities on the crystallographic modifications of calcium metal. Jour. Electrochem. Soc. 106:448-451. 1959.

689. ____ and J.R. Ogren. Electrical properties and thermal expansion of the laves phases, $CaMg_2$ and $MgCu_2$. Jour. Appl. Phys. 29:1523-1525. 1958.

690. ____ and R.L. Smythe. Vapor pressure measurements over calcium, magnesium, and their alloys and the termodynamics of formation of $CaMg_2$. Acta Metallurgica. 7:261-267. 1959.

____, joint author. See under Armstrong, Bailey, Bernstein, Vest.

Smith, J.M., joint author. See under Swanson.

Smith, Wesley G., joint author. See under Heady.

691. Smutz, M., G. Burnet, J. Walker, R. Tischer and E. Olson. Preparation of low oxygen content yttrium fluoride. U.S.A. Res. and Develop. Rept. Iowa State College. 1068. Sept. 1958.

____, joint author. See under Barghusen, Baroch, Knapp, Koerner.

692. Snedecor, G.W. Chi-squares of Bartlett, Modd, and Lancaster in a 2^3 contingency table -- query and answer. Biometrics. 14:560-562.

____, Member of Editorial Board and editor of Queries Section. Biometrics.

____, joint author. See under Walker. D.R.

Soddy, T.S., joint author. See under Gilman, H.

693. Sorokin, P.A. and W.A. Lunden. Power and morality; essay on practices, mentality and reconstruction of government. Porter-Sargent Co. Ed. 1. 190 pp. 1959.

Speake, Daniel W., joint author. See under Haugen.

Speaker, E.B., joint author. See under Hendrickson.

694. Spedding, F.H., K. Gschneidner, Jr. and A.H. Daane. The lanthanum-carbon system. Trans. Metallurgical Soc. of AIME. 215:192-199. 1959.

695. ____, ____, ____. The crystal structure of some of the rare earth carbides. Jour. Amer. Chem. Soc. 80:4499-4503. 1958.

696. ____, A.W. Naumann and R.E. Eberts. Heats of dilution and related thermodynamic properties of aqueous rare-earth salt solutions at 25°C; integral heats of solution of $NdCl_3$. Jour. Amer. Chem. Soc. 81:23-28. 1959.

697. ____, J.E. Powell, A.H. Daane, M.A. Hiller and W.H. Adams. Methods for preparing pure scandium oxide. Jour. Electrochem. Soc. 105:683-686. 1958.

____, joint author. See under Anderson, G.S., Atoji, Powell, Savage, Thoburn.

Speer, V.C., joint author. See under Aldinger, Brown, H., Diaz, Frape, Heady, Wilbur.

St. André, A.F., joint author. See under Aldrich.

698. Staniforth, D.W., C.R. Weber and W.G. Lovely. Cultivation for weed control in soybeans. The Soybean Digest. 19(6):6-8. 1959.

____, joint author. See under Lovely.

699. Stickler, F.C. and L.R. Frederick. Residue particle size as a factor in nitrate release from legume tops and roots. Agron. Jour. 51:271-274. 1959.

700. ____ and I.J. Johnson. The comparative value of annual and biennial sweetclover varieties for green manure. Agron. Jour. 51:184. 1959.

701. ____, ____. Dry matter and nitrogen production of legumes and legume associations in the fall of the seeding year. Agron. Jour. 51:135-137. 1959.

702. ____, ____. The influence of clipping on dry matter and nitrogen production of legume green manures. Agron. Jour. 51:137-138. 1959.

703. ____, ____, W.D. Shrader and H.E. Thompson. Legume green manures or fertilizer nitrogen for corn? Iowa Farm Science. 13:7-9. 1959.

704. ____, W.D. Shrader and I.J. Johnson. Comparative value of legume and fertilizer nitrogen for corn production. Agron. Jour. 51(3):157-159. 1959.

Stritzel, J.A., joint author. See under Heady.

705. Struempler, A.W. and W. Burroughs. Stilbestrol feeding and growth hormone stimulation in immature ruminants. Jour. Animal Sci. 18:427-436. 1959.

Struve, W.M., joint author. See under Loomis.

Suomi, V.E., joint author. See under Newman.

706. Summers, T.E. and W.F. Buchholtz. Time and frequency of recovery of Pythium debaryanum and Pythium graminicolum from roots of growing barley seedlings. Iowa State Coll. Jour. Sci. 33:209-217. 1958.

Sutherland, W.H., joint author. See under Moser.

707. Suzuki, Isamu and C.H. Werkman. Glutathione and sulfur oxidation by Thiobacillus thiooxidans. Proc. Natl. Acad. Sci. 45:239-244. 1959.

708. ____, ____. Chemoautotrophic carbon dioxide fixation by extracts of Thiobacillus thiooxidans. II. Formation of phosphoglyceric acid. Archives of Biochem. and Biophys. 77:112-123. 1958.

709. Svec, H.J. and J. Capellen. Correction of the observed ratio for errors associated with ion current collection and amplification in dual collector mass spectrometers. Iowa State Coll. Jour. Sci. 33:427-430. 1959.

710. ____ and G.D. Flesch. The mass spectra of chromyl choloride, chromyl chlorfluoride and chromyl fluoride. Jour. Amer. Chem. Soc. 81:1787-1790. 1959.

711. ____, ____. New preparation for cromyl fluoride and chromyl chloride. Jour. Amer. Chem. Soc. 80:3189-3191. 1958.

712. ____ and G. Junk. The presence of N_3^+ and N_4^+ in the mass spectra of molecular nitrogen. Jour. Amer. Chem. Soc. 80:2908. 1958.
713. ____, A.A. Read and D.W. Hilker. A proportioning furnace temperature controller. Iowa State Coll. Jour. Sci. 33:139-144. 1958.
____, joint author. See under Capellen, Flesch, Junk.
714. Swanson, Pearl, E. Willis, E. Jebe, J.M. Smith, M.A. Ohlson, A. Biester and L.M. Burrill. Food intakes of 2,189 women in five north central states. Iowa Agric. and Home Econ. Exp. Stat. North Central Reg. Publ. No. 83., Ia. Res. Bull. 468. 25 pp. 1959.
____, Chairman, Manuscript Committee. Iowa State College Press.
____, joint author. See under Leichsenring, Roderuck.
715. Swenson, C.A. The phase transition in solid mercury. Phys. Rev. 111:82-91. 1958.
____, joint author. See under Herman, Jennings, Schirber.
716. Swenson, M., G.K.L. Underbjerg, D.D. Goetsch and C.E. Aubel. Blood values and growth of newborn pigs following subcutaneous implantation of bacitracin pellets. Amer. Jour. Vet. Res. 19:554-559. 1958.
Swiger, Marybelle K., joint author. See under Gardner.
717. Switzer, W.P. Infectious atrophic rhinitis. Vet. Med. 54:230-232. 1959.
718. ____. Infectious atrophic rhinitis. in: Diseases of Swine. pp. 533-550. Iowa State College Press. 716 pp. 1958.

Tabeling, R.W., joint author. See under Fassel, Kniseley.
Talbot, Ross B., joint author. See under Campbell.
719. Tarr, Margherita. Those evergreens around your home. Iowa Farm Science. 13(6): 4 pp. 1958.
720. ____. Landscape plants for Iowa. Iowa State Coll. Res. Bull. P212. 24 pp. 1958.
Tedford, John R., joint author. See under Ladd.
Thielman, H.P., Member of Translation Panel. Journal of Applied Mathematics and Mechanics.
____, translator. See under Kurtsveil, Razumikin, Shimanov.
721. Thoburn, W.C. A portable magnetic field and gradient meter. Rev. Sci. Instruments. 29:990-992. 1958.
722. ____, S. Legvold and F.H. Spedding. The magnetic properties of terbium metal. Phys. Rev. 112:56-58. 1958.
723. Thom, H.S.C. and R.H. Shaw. Climatological analysis of freeze data for Iowa. Monthly Weather Rev. 86:251-257. 1958.
724. Thoma, J.A. and D. French. The dissociation constant for the cyclohexaamylose - β iodine complex. Jour. Phys. Chem. 62:1603. 1958.
725. ____, ____. Studies on the Schardinger dextrins. X. The interaction of cyclohexammylose, iodine and iodine. Part I. Spectrophotometric studies. Jour. Amer. Chem. Soc. 80:6142-6146. 1958.
Thomas, Leo A., joint author. See under Payton.
726. Thomas, W.I. Relation of sample size and temperature to volumetric expansion of popcorn. Food Tech. 12:514-517. 1958.
727. ____ and J.C. Eldredge. Introduce new popcorn hybrid. Iowa Farm Science. 13(9): 2 pp. 1959.
Thompson, H.E., joint author. See under Stickler.
Thompson, J.A., joint author. See under Banks.

728. Thompson, Sam H. Can we improve our livestock markets? Wallace's Farmer and Iowa Homestead. 83(20):60-61. 1958.
729. ____. How to get a better price for hogs. Wallace's Farmer and Iowa Homestead. 83(18):30-31. 1958.
730. ____. Lots of choices when you sell. Wallace's Farmer and Iowa Homestead. 83(17):22-23. 1958.
731. ____. Trends in livestock marketing in Iowa. Wallace's Farmer and Iowa Homestead. 83(19):54-55. 1958.
732. ____. Will integration stick? Wallace's Farmer and Iowa Homestead. 83(9):36. 1958.
733. Thompson, William H. Transportation of poultry and poultry products from the north central states. North Central Reg. Pub. 92. Agric. Exp. Stat., South Dakota State Coll. Bull. 472. 46 pp. 1958.
734. Thomson, G.W. A low cost copying projector. Jour. Forestry. 56: 912-913. 1958.

Tiffany, Lois H., joint author. See under Gilman, J.C., Lichtwardt.

Tillman, Allen D., joint author. See under Woods.

Timmons, J.F., joint author. See under Fischer, Held, O'Byrne.

735. Tintner, G. Eine neue Methode für die Schätzung der logistischen Funktion. Metrika. 1:154-157. 1958.
736. ____. Einkommenselastizitaeten im oesterreichischen Konsum. Oekonometrische Untersuchungen zur oesterreichischen Konsumerhebung 1954/55. Monatsberichte des Oesterreichischen Institutes fuer Wirtschaftsforschung Beilage Nr 57. 32:1-18. 1959.
737. ____. Book review: Moderne Methoden in der Agrarstatistik. Heinrich Strecker. Einzelschriften der Deutschen Statistischen Gesellschaft Nr. 8. Wuerzburg, Germany: Physica-Verlag, 1957. pp. 141, 18 tables, 1 map. D.M. 17.50. Paper. Reviewed in Jour. Amer. Stat. Assoc. 53:756-757. 1958.

____, Associate Editor. Econometrica.

____, Book Review Editor. Econometrica.

____, Associate Editor. Metroeconomica.

____, Associate Editor. Unternehmungsforschung.

____, Associate Editor. Statistische Vierteljahresschrift.

____, Associate Editor. Unternehmensforschung -- Operations Research.

Tischer, R., joint author. See under Smutz.

Tomasi, R.A., joint author. See under Gilman, H.

738. Town, G.R. Engineering aspects of television allocations. Rept. Tel. Allocations Study Organization to the Fed. Comm. Comm. 730 pp. 1959.
739. Toy, S.J. and J.P. Mahlstede. Responses of rose plants to cane coating with melted paraffin wax. Iowa State Coll. Jour. Sci. 33:475-488. 1959.

Tremmel, C., joint author. See under Kniseley.

Udelhofen, joint author. See under Wenkert.

740. Uhrig, Robert E. Operating characteristics of a graphite-moderated subcritical assembly. Jour. Amer. Nuclear Soc. 5:120-126. 1959.
741. Ulmer, M.J. Studies on Spirorchis haematobium (Stunkard, 1922) Price, 1934 (Trematoda: Spirorchiidae) in the definitive host. Trans. Amer. Micr. Soc. 78(1):81-89. 1959.
742. Umaerus, V. The relationship between peroxidase activity in potato leaves and resistance to Phytophthora infestans. Amer. Potato Jour. 36:124-131. 1959.

Umbreit, G.R., joint author. See under Fritz.

Underbjerg, G.K.L., joint author. See under Swenson, M.

743. Vaidya, K.A. Cholinesterase inhibition by extracts of Solanaceae. Master of Science Thesis. Iowa State College. 53 pp. 1958.

____, joint author. See under Orgell.

744. Vance, B. How to grow asparagus. Iowa Farm Science. 13(10): 4 pp. 1959.

745. Van Diest, A. and C.A. Black. Soil organic phosphorus and plant growth. I. Organic phosphorus hydrolyzed by alkali and hypobromite treatments. Soil Sci. 87:100-104. 1959.

746. ____, ____. Soil organic phosphorus and plant growth. II. Organic phorphorus mineralized during incubation. Soil Sci. 87:145-154. 1959.

747. ____, ____. Determination of organic phosphorus in soils. III. Comparison of methods. Soil Sci. Soc. Amer. Proc. 22:286-287. 1958.

Van Huss, W.D., joint author. See under Montoye.

van Tamelen, E.E., joint author. See under Aldrich.

Van Wijk, W.R., joint author. See under Fritschen.

748. Van Zante, Helen J. Techniques for electronic cooking research. Jour. Home Econ. 51(6):454-460. 1959.

749. ____. Hard water and staining minerals. (The washday dilemma) Iowa Farm Science. 13:12-14. 1958.

750. ____ and H. Nakamaya. The effect of microwave energy on the internal temperatures of agar and good cylinders. Jour. Home Econ. 51:170-176. 1959.

751. Vest, R.W., M. Griffel and J.F. Smith. The heat capacity of sodium tungsten bronzes from 1.8 to 4.2° K. Proc. 5th Internat'l. Conf. on Low Temp. Phys. and Chem. (U. Wisconsin Press, Madison) pp. 427-432. 1958.

752. Vinograde, B. Equivalent norms. Iowa State Coll. Jour. Sci. 33:117-118. 1958.

753. ____ and G.P. Weeg. Maximally uncleft algebras and rings. Ill. Jour. Math. 3: 15 pp. 1959.

____, joint author. See under Holl.

754. Voigt, A.F. Hazards associated with thorium metallurgy. in: The Metal Thorium. pp. 296-315. American Society for Metals. Ed. 1. 1958.

____, joint author. See under Chiotti, Katz.

Von Krosigk, C.M., joint author. See under Henderson.

755. Wakeley, R.E. Sociological research on farmer's organizations and agricultural cooperatives. Rural Soc. 22:274-280. 1957.

756. Walker, A.L. Entrance examinations in English. Yearbook of Iowa Council of Teachers of English. Fall, 1958.

757. ____, K.G. Huntress, R.B. Orlovich and B. Mills. Essentials of good writing. D.C. Heath Revised Ed. of Minimum Essentials for Good Writing. 370 pp. 1959.

758. Walker, D.R., C.H. Hendershott and G.W. Snedecor. A statistical evaluation of a growth substance bioassay method using extracts of dormant peach buds. Plant Phys. 33:162-166. 1958.

759. Walker, H.W. and J.C. Ayres. Antibiotic residuals and microbial resistance in poultry treated with tetracyclines. Food Res. 23:525-531. 1958.

760. ____, W.J. Coffin and J.C. Ayres. A resazurin reduction test for the determination of microbiological quality of processed poultry. Bact. Proc. 1959:8. 1959.

Walker, J., joint author. See under Smutz.

761. Walkup, J.K. Safety and fire prevention. in: Production handbook. Sect. 25. 45 pp. Ronald Press Co.

Wallace, T.C., joint author. See under Hansen, R.S.

762. Wallin, J.R. and W.G. Hoyman. Influence of postinoculum air temperature maxima on survival of Phytophthora infestans in potato leaves. Amer. Potato Jour. 35:769-773. 1958.

Walsh, J.E., joint author. See under David.

763. Wardle, N. First aid for farm fires. Iowa Farm Science. 13(5):15-17. 1958.

____, Safety Editor. Wallaces' Farmer and Iowa Homestead.

765. Wassom, C.E. and R.R. Kalton. Evaluation of combining ability in Dactylis glomerata L. IV. Randomness of pollination in topcross and polycross nurseries. Agron. Jour. 50:640-643. 1958.

766. Watson, C.B. The Amana style in architecture. The Iowan Magazine. 7:19-49. 1959.

Watts, Betty M., joint author. See under Hougham.

Waywell, C.G., joint author. See under Loomis.

Weakley, F.B., joint author. See under McKinney.

767. Webb, J.R. and J.T. Pesek. An evaluation of phosphorus fertilizers varying in water solubility. I. Hill applications for corn. Soil Sci. Soc. Amer. Proc. 22:533-538. 1958.

768. Weber, C.R. Ford -- a new soybean. Soybean Digest. 14:14-15. 1958.

769. ____. A new soybean -- it's Ford. Iowa Farm Science. 13:3-4. 1958.

____, Publication Board. Iowa Farm Science.

____, joint author. See under Lovely, Staniforth.

Weeg, G.P., joint author. See under Vinograde.

Weiher, J.F., joint author. See under Katz.

Weipert, E.A., joint author. See under Gilman, H.

Weisenborn, F.L., joint author. See under Aldrich.

770. Weiss, H.J. Deflections of a bridge abutment wing wall considered as a thin trapezoidal plate. Engineering Expt. Station Bull. 12 pp.

Welch, D.E., joint author. See under Davidson.

771. Weller, M.W. The ring-necked duck in the northeast. The Auk. 76: 247-248. 1959.

772. ____. Mourning dove nest in cattail. Iowa Bird Life. 29:24-25. 1959.

773. ____. The orinthologists' guide. Jour. Wildlife Management. 23:124-125. 1959.

774. ____, B.H. Wingfield and J.B. Low. Effects of habitat deterioration on bird populations of a small Utah marsh. Condor. 60:220-226. 1958.

775. Wenkert, Ernest. The biosynthesis of hydrolyzable tannins. Chem. and Indust. p. 906. 1959.

776. ____. Alkaloid biosynthesis. Experientia. 15:165. 1959.

777. ____ and N.V. Bringi. A stereochemical interpretation of the biosynthesis of indole alkaloids. Jour. Amer. Chem. Soc. 81:1474-1481. 1959.

778. ____, ____. A new procedure for forming carbon-carbon bonds. Jour. Amer. Chem. Soc. 80:5575-5576. 1958.

779. ____ and J.W. Chamberlin. The stereochemistry of some resin acid derivatives. Jour. Amer. Chem. Soc. 81:688-693. 1959.

780. ____, B.T. Bernstein and Udelhofen. A novel conversion of derivatives of oxindoles to indoles. Jour. Amer. Chem. Soc. 80:4899-4903. 1958.

____, joint author. See under Aldrich.

Werkman, C.H., Assistant Editor. Enzymologia.

____, joint author. See under Suzuki.

Westlake, D.G., joint author. See under Peterson, D.T.

781. Wheat, J.G., R.E. Atkins, K.J. Frey and E.S. Dyas. Iowa barley and flax variety tests, 1954-1958. Iowa Agr. Exp. Sta., Agron. 450. Nov., 1958.

782. ____, ____, ____, ____. Iowa winter and spring wheat variety tests 1954-1958. Iowa Agr. Exp. Sta., Agron. 451. Nov., 1958.

783. ____, K.J. Frey, J.A. Browning, R.E. Atkins and E.S. Dyas. Iowa oat variety trials summary 1954-1958. Iowa Agr. Exp. Sta., Agron. 449. Oct., 1958.

____, joint author. See under Atkins.

784. White, R.F. and J.G. Graca. Multinomially grouped response times for the quantal response bioassay. Biometrics. 14:462-488. 1958.

White, R.W., joint author. See under Chiotti.

785. White, W.C., L. Dumenil and J. Pesek. Evaluation of residual nitrogen in soils. Agron. Jour. 50:225-259. 1958.

786. ____ and J. Pesek. Nature of residual nitrogen in Iowa soils. Soil Sci. Soc. Amer. Proc. 23:39-42. 1959.

787. Whitney, Richard R. Numbers of mature walleyes in Clear Lake, Iowa, 1952-3, as estimated by tagging. Iowa State Coll. Jour. Sci. 33:55-79. 1958.

788. Wiggans, S.C. Total nitrogen in blasted and normal oat panicles. Agron. Jour. 51:183. 1959.

789. ____. The relationship of total nitrogen percentage to yeidl, test weight and groat percentage of oats grown at different locations. Proc. Iowa Acad. Sci. 65:197-200. 1958.

790. ____ and R.H. Shaw. The effect of high temperatures at varying stages of growth on kernel production in oats. Proc. Iowa Acad. Sci. 65:201-205. 1958.

791. Wilbur, R.D., L.Y. Quinn, D.V. Catron, V.W. Hays and V.C. Speer. Influence of selected carbohydrates on the development of intestinal microorganisms in the baby pig. Jour. Animal Sci. Proc. of Amer. Soc. Animal Prod. 17:1160-1161. 1958.

792. Wilhelm, H.A. and R.A. Foos. A countercurrent liquid-liquid extractor. Indust. and Engr. Chem. 51:633-636. 1959.

793. ____ and R.E. McCarley. List of high purity metals available from American producers. U.S.A.E.C. Report. I.S.C. - 1029. Ed. 1. 1958.

____, joint author. See under Chiotti, Koerner.

794. Williams, D.E., G. Wohlauer and R.E. Rundle. Crystal structures of nickel and palladium dimethylglyoximes. Jour. Amer. Chem. Soc. 81:755. 1959.

Willis, Elisabeth, joint author. See under Swanson, P.

Wills, B.L., joint author. See under Campbell.

795. Wilsie, C.P. Hybrid vigor, yield variance and growth habit inheritance in divergent alfalfa crosses. Report of the 16th Biennial Alfalfa Improvement Conf., New York. pp. 21-33. 1958.

796. ____. Improved alfalfas for 1959. Iowa State Coll. Bull. P251. 4 pp. Aug. 1958.

____, joint author. See under Scholl.

Wingfield, B.H., joint author. See under Weller.

Wintersteiner, O., joint author. See under Aldrich.

797. Wittenberg, D., D. Aoki and H. Gilman. Some reactions of silyllithium compounds with ethers. Jour. Amer. Chem. Soc. 80:5933-5936. 1958.

798. ____, M. V. George, T. C. Wu, D. H. Miles and H. Gilman. Addition of silylmetallic compounds to the azo and azomethine linkage. Jour. Amer. Chem. Soc. 80:4532-4534. 1958.

799. ____ and H. Gilman. Lithium cleavages of triphenyl derivatives of some group Vb elements in tetrahydrofuran. Jour. Organic Chem. 23:1063-1065. 1958.

800. ____, ____. Reactions of silyllithium compounds with derivatives of carboxylic acids. I. Triphenylsilyllithium and acetylchloride. Jour. Amer. Chem. Soc. 80:4529-4531. 1958.

801. ____, H. A. McNinch and H. Gilman. The reaction of some silicon hydrides with sulfur-containing heterocycles and related compounds. Jour. Amer. Chem. Soc. 80:5418-5422. 1958.

802. ____, T. C. Wu and H. Gilman. Cleavage of diphenylsulfone and diphenylsulfide by triphenylsilyllithium. Jour. Organic Chem. 23:1898-1903. 1958.

____, joint author. See under George, Gilman, H.

Wohlauer, G., joint author. See under Williams.

803. Wolfenbarger, D. and E. T. Hibbs. Insecticides and spray schedules for the control of cabbage leaf feeding Lepidoptera. Jour. Econ. Ent. 51:443-445. 1958.

804. Wolter, F. J. and H. Diehl. Plutonium compounds and process for their preparation. U. S. Patent 2,819,280. Library of Congress. January 7, 1958.

805. Woods, W. R., W. D. Gallup and A. D. Tillman. Comparative value for sheep of some protein supplements fed at three protein levels. Jour. Animal Sci. 17:758-762. 1958.

806. Worden, D. G. and G. C. Danielson. Electrical resistivity of thin films of potassium of 100° K. The Phys. and Chem. of Soils. 6:89-95. 1958.

Worley, G. W., joint author. See under Hendrickson.

807. Wu, T. C. and H. Gilman. Cleavage of the silicon-silicon bond of hexaphenyldisilane. IV. Jour. Organic Chem. 23:913-914. 1958.

____, joint author. See under Wittenberg.

Yamamura, S. S. joint author. See under Fritz.

808. Yatco-Manzo, E., F. Roddy, R. G. Yount and D. E. Metzler. The catalytic decarboxylation of pyruvate by thiamine. Jour. Biol. Chem. 234:733-737. 1959.

Yeb, M., joint author. See under Heady.

Yerick, R. E., joint author. See under Banks.

Yoder, L., joint author. See under Cheng.

809. York, G. T. Field tests with the fungus Beauveria sp. for control of the European corn borer. Iowa State Coll. Jour. Sci. 33:123-129. 1958.

810. Yount, R. G. and D. E. Metzler. Decarboxylation of pyruvate by thiamine analogues. Jour. Biol. Chem. 234:738-741. 1959.

____, joint author. See under Yatco-Manzo.

811. Zillinsky, F. J., K. Sadanaga, M. D. Simons and H. C. Murphy. Rust-resistant tetraploid derivatives from crosses between Avena abyssinica and A. strigosa. Agron. Jour. 51:343-345. 1959.

____, joint author. See under Murphy, H. C.

812. Zimmermann, W. J., E. D. Hubbard and H. E. Biester. Studies on trichiniasis in Iowa wildlife (1955-56 and 1956-57 seasons). Jour. Parasitology. 45:87-90. 1959.

813. ____ and Louis H. Schwarte. Trichiniasis in dogs and cats of Iowa. Jour. Parasitology. 44:520-522. 1958.

Zuech, E. A., joint author. See under Gilman, H.